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# SOCIAL AND ECONOMIC RESEARCH IN GREAT BRITAIN

IN considering the provision made for research in Great Britain into social and economic questions, the Clapham Committee, reporting in July 1946, was satisfied that unless the existing arrangements and plans were upset in some future economy campaign, the provision for such research within the government machine was much more likely to be hampered by the lack of properly trained staff than by failure to realize the importance of the work to be done. Developments in the departments and in the central secretariat promised well for the future of research in this field. It was, however, highly desirable that the Government departments which collect and analyse material relevant to social and economic research should be in continuous contact with outside experts, who could keep them aware of the needs arising in the speculative branches of the field and who could assist in assessing the value and possible uses of material which is already being collected. Equally it was desirable that there should be continuous contact between the relevant divisions within the different departments, both to avoid overlapping and to ensure that the potential value for research purposes of the material available was exploited from every point of view.

The Clapham Committee accordingly recommended the establishment of an interdepartmental committee charged with the duty of bringing to the notice of departments the potential value for research purposes of the material which they collect, and suggesting new methods and areas of collection. The appointment of such a standing committee was announced by the Chancellor of the Exchequer on January 21, 1947, and in its first report now issued*, the Committee examines the availability, for academic research, of statistical data and other descriptive matter available in Government departments. Much of this material is already known to and used by academic research workers, and the departments themselves benefit considerably from the fundamental research or studies in methodology proceeding at the universities. The interdependence of the departments and the universities in the field of the social sciences is now clearly recognized.

The Interdepartmental Committee recognizes the value of the close personal contacts established during the War, when many members of university staffs were employed in Government departments, and it is convinced that there is no adequate substitute for them. Such contacts should not only be maintained but also multiplied; and the Committee regards it as one of its principal functions to stimulate all forms of collaboration, whether formal or informal, between the departments and research institutions. Personal contacts in themselves are not enough; but while the Committee's recommendation remains designed to supplement, not to supersede, the direct contacts now existing between individuals, it is not likely to

* Report of the Interdepartmental Committee on Social and Economic Research. (Cmd. 7537.) Pp. 16. (London : H.M. Stationery Office, 1948.) 4*d*. net.

sponsor expensive schemes which aim at theoretical completeness as regards the covering of information, rather than what is economically worth while in view of the effects of such personal contacts. The Committee acknowledges the assistance given in this part of its work by the memorandum submitted by the National Institute of Economic and Social Research as a result of the conference on research relations with Government departments, to which reference was made in some detail in the last annual report of that Institute (see *Nature*, July 31, 1948, p. 197).

Before tackling the wider and more general questions confronting it, however, the Committee thought it advisable to ensure so far as possible that any new schemes which departments might be projecting for collecting and tabulating social and economic material should at the outset make reasonable provision for research needs. Information obtained about the number and condition of the people, their health, their work and their needs is obviously capable of much fuller use when it is so handled at the outset that it can serve more than immediate administrative requirements. From the point of view of the individual citizen, quite apart from that of economy, there are obvious advantages in such co-operation; and it is encouraging to learn that not only is there wide interest in the work of the Committee and a general willingness to co-operate, but also that three of the major departments of State, the Ministry of Agriculture and Fisheries, the Ministry of Education and the Board of Trade have already asked for guidance on particular tabulation schemes.

In studying the material which Government departments collect and publish, the Committee decided to work in the first instance through sub-committees making a close study of one department or group of departments, and strengthened as needed by co-opting additional academic or other members with special knowledge of the particular field. In these surveys, the immediate objects are to find out what information is collected, the extent to which this information could be made available, and whether there are any fields of statistical or other information in which a change in present methods of collection or treatment might benefit departmental or other research workers. These surveys began with the Ministry of Labour and National Service, Prof. R. G. D. Allen being co-opted to the sub-committee concerned. A guide to the material available through this Ministry has already been published, but the sub-committee's report also led to a recommendation to the Ministry that some of the unpublished information already in the possession of the Ministry, such as information about working days lost through industrial disputes, wages and juvenile employment, should be assembled and published. Other information, it was suggested, should be published in greater detail or more frequently.

Man-power considerations may well preclude action on some of these recommendations at the present time; although if like recommendations emerge as the outcome of the work of the sub-committee at present studying the work of the Board of Trade, it might well be possible to implement them by transference and not by the engagement of further staff. Investigations along these lines should assist the research worker to find out what material is available in the departments, and it should be noted that the Committee considers that the publication of the Guide of Current Official Statistics should be resumed at the earliest possible date and not delayed for the incorporation of references to unpublished material which is also available.

Location, however, is only one aspect of the subject. The research worker also wants to be certain that the material he requires will not be destroyed before he can consult it. One of the main functions of the Public Records Office is to ensure that research material is not destroyed, and as the pamphlet on "The National Register of Archives", published in 1945, shows, the services of the Office to social and economic research in the preservation of documents are not limited to material in the possession of Government departments. The Committee, while appreciating the importance of the work of the Public Records Office in this field, suggests that it has been regarded too exclusively as a source of information about the past; certain proposals are accordingly made with the view of enabling the Record Office to offer a more positive contribution to those engaged in contemporary research. One such proposal, that the words "or useful for social and economic research" should be added to the paragraph inserted in every schedule governing the disposal of departmental records to ensure that they are examined by a competent officer before they are destroyed, has already been accepted.

The Interdepartmental Committee further proposes that the Public Record Office should issue a publication classifying all the documents preserved either at the Public Record Office itself or elsewhere under its jurisdiction. It suggests further that more might be done in framing the schedules which govern the preservation and destruction of records to make them more immediately intelligible to research workers. Attention is also directed to the special case of war-time collections of data in departments, and to the risk that these may not be sufficiently used for research purposes.

The scope of the Committee was limited to research work in Government departments, but it does not overlook the importance to social and economic research generally of avoiding the dispersal, loss or destruction of the records of industries now nationalized or being nationalized. This matter lies outside the terms of reference of the Committee, and is related to the question of the preservation of business records generally. Nevertheless, the Committee has brought the matter to the notice of the Office of the Lord President of the Council, and this report should do much to help the work of the British Records Association in this field. The suggestions in this report could find considerable application to business records also, as will be apparent to any reader of the paper by Dr. Chaloner on "Business Records as a Source of Economic History", read before the Northern Branch of Aslib last autumn and now available in the *Journal of Documentation*. That

paper was specially concerned with the selective preservation of business records in libraries. Here the principles laid down by the Interdepartmental Committee regarding the confidential character of Government information have a close bearing, and some at least could be applied. If it is a recognized duty of Government departments towards the society of which they are the institutional agents to make available, at least for the purposes of scientific inquiry, as much as possible of the information which they possess, business firms can scarcely disclaim all such responsibility. Indeed, although much that passes for the history of particular firms or industries scarcely meets the criteria of R. E. Collingwood in "The Idea of History", at least the volume of such monographs is considerable enough to indicate that industry recognizes a responsibility of this character. In the opinion of the Committee, a *prima facie* case exists for publishing, or making otherwise accessible, all information of general social utility, unless there is good reason to the contrary; and such *obiter dicta* cannot well be limited to Government departments.

Whether this be universally applied or not, it is necessary to be clear as to what constitutes a good reason to the contrary. Government departments have first to observe faithfully statutory requirements, though opportunities might well be taken, in amending legislation, to modify obsolete requirements. The requirements of security and public policy have also to be met, in the Departments of State and in business or industry, though liberal interpretation of rules may well be called for; and in Government departments and in industry practical administration must not be hampered. Likewise, it is reasonable to insist that the cost of making the information available should not be out of proportion to the importance of the subject-matter; and whatever the source of the information, public interest demands that the obligation, whether statutory or otherwise, ensuring that individual persons, firms and other entities are not publicly identifiable, must be discharged.

That there will be some difficulties is not denied; but the Committee points out that such difficulties have been surmounted even in fields in which access to information of a personal or individual nature is essential. The general observance of such a code of rules in respect not only of information available in Government departments or commercial firms, but also information obtained by the departments for administrative purposes from trade unions, employers' federations and trade and professional associations, and the scheduling of such documents on similar lines might immensely enrich the field of research available for accredited research workers. It is a necessary and reasonable corollary to any such proposals that all persons concerned exercise particular care that the material is only used by such workers.

Besides the confidential material, there is much non-confidential information, particularly of a statistical nature, which could be made available for social and economic research. Copies of such unpublished documents might well be distributed to specialized libraries where outside research workers might consult them. The Committee, in fact, compiled such a list, including university libraries, research libraries within the universities and the libraries of other research bodies of standing and of learned societies. A number of departments have already indicated their willingness to co-operate, and the intention is to ascertain by experiment the documents which such libraries wish to receive, and then to see if regular distribution could be arranged.

The emphasis on this report is on finding ways in which the Departments of State could assist the outside research worker more effectively than they do now. There is the complementary question, which may well increase in importance, of the help which research workers can incidentally give the Departments of State. There are always academic research projects in progress which bear at least indirectly on Government problems, and in this connexion the Committee refers to the value of the Register of Research in the Social Sciences compiled by the National Institute of Social and Economic Research. The need is primarily for collaboration between the Departments of State and research workers; and this first report warrants the belief that the Standing Committee will provide a powerful stimulus to such co-operation, and even to the use for social and economic research of the much larger amount of material available in business records.

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# FORCES INSIDE THE ATOMIC NUCLEUS

## Nuclear Forces

By Prof. L. Rosenfeld. (Monographs on Theoretical and Applied Physics, Vol. 1.) Pp. xix+181. (Amsterdam: North-Holland Publishing Co., 1948.) £1 4*s*. 5*d*.

THERE is a mass of experimental material in nuclear physics, much of which gives information about the forces acting between nuclear particles. The theory of nuclear forces, on the other hand, is still inadequate. Even the law of force between two nucleons is unknown, though meson theory suggests a form, but leaves numerous parameters to be settled by comparison with experiment. The research literature of nuclear physics is consequently chaotic, and the appearance of a book on the subject is to be welcomed. In his preface, Prof. L. Rosenfeld explains the reasons which led him to adopt a discursive approach to his subject at the expense of brevity and at the risk of losing the basically simple thread of the argument. The result has been a book which is not easy to read quickly by anybody who wants to discover the central ideas of the subject. The wealth of detail, which might well have been relegated to appendixes, will prove very valuable to research workers in the field, particularly to those entering it for the first time, but may well try the patience of the more general reader trying to learn something of this important branch of physics.

Only volume 1 has so far appeared, and it is a pity that a list of references and a provisional subject index could not have been prepared for it. The text abounds with references to a bibliography at the end of the book; but the reader who turns to the end of the present volume will find a disappointing blank. This is all the more unfortunate in connexion

with the table of nuclear data and figures summarizing them, which are referred to in the text. It is to be hoped that the remaining volumes will soon become available, so that the student who wishes to read the original papers may know where to find them, and be able to consult what must be a very useful compilation of data.

The present volume, after an introductory survey of the whole field (Part 1), is confined to detailed consideration of two-nucleon systems, on the hypothesis that only central forces are effective. The first chapter of Part 1 deals with the elementary particles of physics and their properties. How difficult a task it is to write a book about a rapidly developing subject is demonstrated by the absence of any reference to the recent discovery by the Bristol physicists that there are at least two kinds of mesons in the cosmic rays, and that the mesons which occur at sea-level are not those which play a part in the nuclear forces. This discovery, though scarcely a year old, has called for revision of our ideas on the subject, which could not be included in this volume. The remainder of Part 1 is devoted to considerations of the simpler properties of nuclei, such as their binding energies, radii, etc., and the arguments pointing to the saturation property of nuclear forces.

In Part 2, one chapter is devoted to general considerations on the wave equations of the two-nucleon system, two chapters to detailed considerations of the proton–neutron system (that is, the deuteron and the scattering of neutrons by protons), one chapter to the proton–proton system and a final chapter to a comparison of the forces between like and unlike nucleons. These topics are treated with an encyclopædic thoroughness which will certainly make the book a standard work of reference for many years to come.

The book, though written in English, is printed in Holland. The printing is attractive and pleasantly free from misprints; but the formulæ are disfigured by symbols in strange types and a luxuriant growth of prefixes, affixes and suffixes. These latter also disfigure the text by having made it impossible for the printer to keep an even spacing between the lines; they could well have been omitted without loss of clarity.

M. H. L. PRYCE

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# A SOUTH AMERICAN ANTHROPOLOGICAL SYMPOSIUM

## Handbook of South American Indians

Edited by Julian H. Steward. (Smithsonian Institution: Bureau of American Ethnology, Bulletin 143.) Vol. 3: The Tropical Forest Tribes. Pp. xxvi+986+126 plates. Vol. 4: The Circum-Caribbean Tribes. Pp. xx+609+98 plates. (Washington, D.C.: Government Printing Office, 1948.) n.p.

THE first two volumes of this work, dealing with the marginal tribes and the Andean civilizations, were introduced in *Nature*, Nov. 30, 1946, p. 769. Those now under review cover vast areas in eastern and northern South America, besides the West Indies and most of Central America south of Mexico. These regions were more sparsely covered by published information even than those dealt with in the first two volumes, so their preparation has involved a great deal of research, one result of which was to show that the arrangement of sub-areas planned for vol. 3 was largely artificial, though it was too late to alter it, and that much of the information on Colombia in vol. 2 might more properly have been included in vol. 4. The editor points out that the fragmentary nature of the information about many of the tribes treated in vol. 3 has resulted in prolixity rather than in brevity, since it has forced authors to let original accounts speak for themselves, retaining much detail which may be unimportant, and has prevented them from making reliable summaries of the basic features. This is not to say that these volumes are less valuable than their predecessors or any less necessary to students of South American archæology and ethnology; in fact, they represent, if anything, a greater advance on our previous knowledge about the areas they deal with.

In vol. 3 the emphasis is, naturally, on the modern Indians rather than on the archæology, about which there is little to say, although parts of eastern Bolivia and the Napo region of Ecuador, about which at least a little is known, seem to have escaped mention both here and in vol. 2. The Indians described are mainly in their original state, unlike those in the Andes in that they are little affected by culture contact. As a matter of convenience, the tribes of northern Colombia and of Venezuela north of the Orinoco are dealt with in vol. 4.

A general principle of great interest and importance, which is indicated by the survey of this area, is that the tropical forest type of culture spread upstream from a centre in the lower Amazon and the Guianas as far as its limit at the edge of the Andean zone, and it is considered that there was little cultural diffusion overland either from the Orinoco basin or the Andes. It is further suggested that the tropical forest culture came originally from the circum-Caribbean area, and the argument is carried further in vol. 4, where the idea of a circum-Caribbean culture, whence the forest culture is derived by degeneration, is developed. It is shown that, at the time of the conquest by the Spaniards, a number of tribes in that area had an elaborate culture, now vanished, which probably resembled that of the Formative Period in Mexico and the Andes, with a strong bias towards the latter. This implies that cultural flow in Central America was mainly from the south. Opportunity is taken to point out the weakness of the theories of origin of American civilizations which ascribe them to the areas least known at the time of enunciation, and to show how inherently improbable is the idea that the essentials of the higher civilizations could have come from the forests.

In contrast to vol. 3, there is a good deal to say in vol. 4 about archæology, and there are extremely useful summaries dealing with the Central American countries, Venezuela and the West Indies, by acknowledged experts such as Strong, Lothrop, Alfred Kidder II and Rouse. There is a large amount of information about the modern tribes, in spite of the fact that many of them are relatively degenerate survivals, as has already been implied. The area dealt with includes northern Colombia, but it is rather unexpected to find the Cayapa and Colorado of western Ecuador in this volume.

The extent of our debt to the Bureau of American Ethnology for this vast undertaking gradually becomes apparent as publication advances. In order that we may get the best out of it, an index is urgently needed, and it is to be hoped that one is planned for the final volume.

G. H. S. BUSHNELL

# TECHNICAL WRITING

## The Presentation of Technical Information

Based on four Public Lectures given at University College, London. By Prof. Reginald O. Kapp. Pp. xi+147. (London: Constable and Co., Ltd., 1948.) 6*s*. net.

SINCE the lectures on which this book is based were delivered in April and May of 1947, the publication of Sir Ernest Gowers' "Plain Words" has stolen some of Prof. Kapp's thunder. There is some common ground in the two books, but Prof. Kapp is concerned with the presentation of technical information and deals with the choice and use of words only so far as they contribute to that purpose: whether or not technical terms, words are to be chosen deliberately so as to serve the technical ideal of fitness for the purpose. That is the ideal which is in Prof. Kapp's mind throughout, just as it dominated Prof. J. R. Nelson's "Writing the Technical Report", a second edition of which appeared last year. Prof. Kapp insists that the presentation of technical information demands the use of what he terms functional English—language in which words are chosen and sentences constructed so as to express the writer's meaning clearly and without ambiguity, and are as appropriate to his purpose as the units selected and used by the designer of an engineering construction. Functional English, he claims, presents facts and ideas simply and logically, but jargon is eschewed by him as firmly as by Sir Ernest Gowers or by Quiller-Couch in a lecture that few scientific writers appear to have discovered.

In his 150 pages, Prof. Kapp includes much that should help the technical or scientific writer to select the words most appropriate for his paper, report or book, and which will best assist the reader—or hearer, for Prof. Kapp is concerned with spoken as well as written exposition—to understand his meaning. Primarily, it is the postgraduate student to whom the book is addressed, but it should be equally welcomed by other students at an earlier stage, though Prof. Kapp provides no ready-made guide or model to be copied. The book is a challenge to real thinking about the task of presentation.

The expositor's first task before he even begins to select his material is to be quite clear in his own mind as to the purpose for which the information to be supplied is required and the reader or audience for whom it is intended. Unless we know the exact purpose to be served we cannot choose the appropriate tools for the task. No commoner error is made, however, in presentation than neglect to decide on that purpose or on the reader to be addressed. By apposite examples, Prof. Kapp illustrates a number of simple rules, observance of which will enable the scientific man to present the results of his investigations in much more readable and therefore effective form. Moreover, Prof. Kapp does this, too, by stimulating thought as well as by pertinent comments on prevalent use and abuse of words, and his book is admirably designed to meet a need voiced at the Royal Society Scientific Information Conference as well as in an ever-growing volume of books and papers.

Prof. Kapp's own book is original in its approach, and his treatment of the theme is clear, vigorous and searching. The book may justly be preferred to some of its more voluminous predecessors, but its merits can scarcely justify the virtual ignoring of all other publications on the subject; and some of his readers might well be grateful for references to other books or papers in which they could pursue their study of a subject Prof. Kapp illuminates but scarcely exhausts. He refers, indeed, but vaguely to a paper on the subject in the *Journal of the Institution of Electrical Engineers* since published by that Institution with others under the title "The Presentation of Engineering Evidence", and apart from the considerable number of books, some indeed of unequal value, concerned with the writing of reports or scientific papers, he gives his readers no indication of the existence of useful and entertaining literature on the handling of words themselves whether for technical or general purposes. R. BRIGHTMAN

# INDEX KEWENSIS

## Index Kewensis Plantarum Phanerogamarum

Supplementum Decimum: Nomina et Synonyma Omnium Generum et Specierum ab initio Anni 1936 usque ad finem Anni 1940 nonnulla etiam antea edita complectens. Ductu et consilio A. W. Hill (obiit 1941) et E. J. Salisbury. Pp. iii+251. (Oxford: Clarendon Press; London: Oxford University Press, 1947.) 84*s*. net.

FROM the time of its original appearance in 1893, the "Index Kewensis" has been one of the monumental works in the literature of systematic botany, and the publication of Supplements at regular intervals has always marked a notable stage in the records of plant taxonomy. The appearance of the tenth Supplement is no exception, and although on this occasion there has been inevitable delay in its production, it will none the less receive a warm welcome from botanists throughout the world. To the authorities at Kew every botanical institute must feel indebted for the continuation of an indispensable work of reference.

The present volume covers the five-year period 1936–40, and in its general plan it is similar to previous Supplements. Each page carries three columns, and generic names are arranged alphabetically, as also the specific names under each genus. Some idea of the immense amount of work involved in the preparation of an index of this kind may be obtained from the fact that each of its 251 pages deals with about 105 specific names. This gives an indication also of the contribution which has been made to the systematic study of Phanerogams in the period under review. Not only have large numbers of new species been described, but also numerous new genera have been established, notably in the families Cactaceæ, Compositæ, Gramineæ, and Rubiaceæ. The delimitation of genera in these and other families not infrequently presents considerable difficulty, and it is not surprising that some of the new generic names which appear in the Supplement are due to the elevation of previously recognized sub-genera.

As would be expected, the species which have been described as new to science are distributed among many genera; but the additions to certain of them, such as *Carex*, *Hieracium*, *Peperomia*, *Piper*, *Rubus*, *Quercus* and *Salix*, are conspicuous by their number. The pages of the Supplement as a whole, however, are testimony to the amount of systematic work which was achieved before the War brought botanical exploration temporarily to a standstill, and they give

evidence of the substantial contribution which has been made to our knowledge of the world flora. Such an authoritative list of the names of plants, giving the author and place of publication of each, together with reference to synonymy and geographical distribution, is indispensable to all workers on the taxonomy of flowering plants.

An additional feature which distinguishes this from earlier Supplements is the insertion of an asterisk against those entries where an illustration accompanies the description of the new species. In this simple way the "Index Kewensis" will continue the function of the "Index Londonensis", a work which was brought to a conclusion in 1941.

J. R. MATTHEWS

## ENCYCLOPÆDIA OF EYES

### Tabulæ Biologicæ

Vol. 22: Oculus, Pars 1. Editores: K. Steindorff, F. P. Fischer, J. S. Friedenwald, Arnold Sorsby. Pp. viii + 408. (Amsterdam: Dr. W. Junk, 1947.) 70 fl.

ONE of the functions of science is to collect information and to classify it. Some of the information so collected may appear to any one person to be trivial or of little importance, but let that person remember that he is not the only oyster in the bed, and he will realize that the sand grains around him may become pearls for others. To one interested in the activities of the human eye there may seem to be little significance in measurements which relate the width of the ocellus of an ant to the breadth of its head; but to another, interested in the behaviour of ants, this information may be of far more value than statistics on the occurrence of blondes in Austria, or the relation between intraocular pressure and the thymus gland. The first part of "Oculus" contains collected numerical data on the structure and anatomy of eyes of all types, on the behaviour of the pupil and on vascular pressures in the eye; and the reader will find a wide diversity of subject-matter, including such topics as those mentioned above. The net is cast wide and the information collected is vast and various. Three further parts of the book are to follow, so that almost every aspect of the eye will be dealt with, each by a different author.

The task of collecting the data and preparing it for publication was largely undertaken or inspired by the late Kurt Steindorff, who clearly saw the advantages to be gained by collecting together as much information as possible in order to assist in elucidating the mysteries of vision. He might be described as the oculomotor nucleus.

In such a subject as vision, upon which the relevant literature is immense and still rapidly growing, it is easy to be critical on the grounds that such and such a table is not included in this volume; but since most of us who work on vision have experienced the mixed thrill and disappointment of finding that our much cherished ideas were either suggested or carried out in the last century, such criticism necessarily loses much of its force. Nevertheless, on such matters as the structure and distribution of the retinal constituents it is disappointing, for example, to find no references to the data collected by Polyak or Osterberg. There has clearly been some inevitable delay in the publication of the volume, and thus many of the more recently derived data are not included. Moreover, the index is to appear in a later volume and the bibliographies are arranged numerically, more or less in order of appearance in the text, and not alphabetically according to authors, so that it is difficult to be certain that one does not miss information through searching for it in the wrong place. Such difficulties will, of course, vanish when the whole work is published, and, when this occurs, ophthalmologists of all types will have an extremely valuable compendium of information.

E. N. WILLMER

## VEGETABLE GROWING

### Vegetable Growing

By Prof. James Sheldon Shoemaker. Pp. v + 506. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 27*s*. net.

IT is unusual to find a North American book on any aspect of practical horticulture which is of much direct value in Great Britain. Prof. J. S. Shoemaker, perhaps because he is primarily a man of science, has produced a book which is an exception to the rule. The reason lies in the method of approach to the subject, which is more through the requirements of the crop than its detailed culture. While it is true that much of the discussion on varieties has little application in Britain, yet, because of the closer horticultural links of Canada with the home country, many more English varieties are included than one would find in a book from the United States.

Because of the prime importance of good seed in successful vegetable cultivation, the book starts with a discussion on seed production. This is undoubtedly a most valuable section, since few books on vegetables give more than cursory attention to the subject. The major part of the work is devoted to the specific crops, grouped according to use; for example, corn crops, root crops, salad crops, etc. The traditional procedure of giving preliminary chapters on soils, fertilizers and other considerations has been abandoned in favour of discussing these problems in relation to each crop, thus enabling direct application of research findings to be presented in their proper context. It is this treatment which lifts the book out of the general run of gardening manuals and raises it to scientific levels.

A surprising omission, however, in a book of this high standard is that of scientific names and botanical characteristics. The history of each vegetable is most admirably summarized, but to the serious student the interest and value would be greatly enhanced by reference to the botany of the crop. This is particularly true of the last chapter, on insect and disease control. Of what value to a student, especially in another country, is a reference to "early blight" and "late blight" of celery unless he knows that these are due to two different fungi, *Cercospora apii* and *Septoria apii*? Again, what is one to understand by "haywire", "calico" and "jelly-end rot" of potatoes? Even where the genus of an insect or a fungus is mentioned or clearly obvious, addition of the specific name would avoid confusion with other species possibly more common in another country. Perhaps in a second edition the author will bear in mind the needs of workers and students in Britain and elsewhere.

R. H. STOUGHTON

## Cours de mécanique

Par Henri Beghin. Tome 1. Chapitres 1 à 3. Pp. ix+102. Chapitres 4 à 7. Pp. 103–201. Chapitres 8 à 11. Pp. 202–367. Chapitres 12 à 14. Pp. 368–488. Chapitres 15 à 18. Pp. 489–588+9. (Paris : Gauthier-Villars, 1948.) 1,800 francs.

IN order to avoid the current delays of printing, M. H. Beghin's book has been manifolded from typescript, a process which does not make for elegance; but the merits of the work are not thereby obscured. Based on lectures given at the École Polytechnique, the first volume deals with kinematics, with elementary statics, and with dynamics of a particle and of simple rigid bodies, going as far as Lagrange's, Appell's and Hamilton's equations. Vector methods are used when appropriate, but are not overdone.

A preface by General Brisac, commandant of the École Polytechnique, claims three points of M. Beghin's work for special praise—its simple presentation of principles, its systematic exposition of mechanics as an experimental science, and its sense of concreteness. The book shares with most other French treatises on rational mechanics a clear and logical view of dynamical principles and a power of simple yet precise exposition. But the contact with reality is a marked feature, and here M. Beghin's account is akin to the best of British text-books ; and he is not above including some exercises for the student, though these are often of the type which we in Great Britain should expect to see as worked examples to illustrate the text. Fortunately, he despises the monotony of "A uniform rod of mass $m$ and length $2a$", and the majority of his examples are genuinely instructive. The long Chapter 7, "Exercices simples de mécanique terrestre", is full of good sound matter, clearly expressed, and of definite practical importance. Granted the French recognition of the value of pure science to the Fighting Services, it is easy to believe that M. Beghin's courses at the École Polytechnique were greatly appreciated.

The second volume is to deal with gyroscopic motion and with the mechanics of fluids and of elastic solids.

## The Electrolytic Capacitor

By Alexander M. Georgiev. Pp. xii+191. (New York and Toronto : Murray Hill Books, Inc. ; London : Crosby Lockwood and Son, Ltd., 1945.) 15*s*. net.

IN this age of electronics, we have ceased to marvel at the sight of incredibly complicated circuits being packed into ever smaller and smaller boxes. Few probably pause to consider the great part that has been played by the development of the electrolytic condenser in order to achieve these feats of space compression.

In Mr. A. M. Georgiev's book, all the aspects of electrolytic capacitors are considered, and running right throughout the book there is the comparison of the 'wet' with the 'dry' type of electrolytic condenser. The main theme is of a commercial and engineering nature, and a good deal of space has been devoted not only to the manufacturing processes but also to the details of the electrical equipment necessary for testing and fault-finding. On the other hand, the more academic aspect has not been overlooked, and a whole chapter (5) has been devoted to an outline of the many and various theories and hypotheses that have been advanced in an attempt to explain this curious dielectric surface of an aluminium anode, which is the starting-point of the whole subject.

There is much information to be obtained from this book, and in addition there is a very extensive bibliography, index, list of relevant patents and glossary (in which many of the terms are quite elementary). As such, this volume will be of much interest not only to qualified chemical engineers, but also to the scientific layman who is interested in the actual manufacture or use of electrolytic condensers.

## Introduction to Wireless

By W. E. Pearce. Pp. viii + 247. (London : G. Bell and Sons, Ltd., 1948.) 7*s*. 6*d*. net.

THIS book is likely to appeal to the layman who is anxious to know something about how his wireless set works, and who may be expected to have forgotten all he ever knew about elementary electricity and magnetism. This may justify the inclusion of the material in Chapters 2–7. From Chapter 8 onwards the author does deal with radio; but the book is not strictly an "Introduction to Wireless" in the sense that it might form a suitable first-course text-book for serious students. The ground covered is too wide and the treatment too general and not sufficiently rigorous.

As a book for the general reader not concerned with becoming an expert, the book is well written and apparently free from very serious errors, although in places there is some confusion of thought, as on p. 99, for example, where the analogies between potential and kinetic energy on one hand and the energy in the electric and magnetic fields on the other seem to have become slightly mixed.

The author would have been better not to invite the reader to doubt his (the author's) capabilities by describing certain phenomena as "difficult to explain".

The book is well produced, and the text and diagrams are clear and readable. W. R.

## Bird Haunts in Northern Britain

By G. K. Yeates. Pp. 175 + 119 plates. (London : Faber and Faber, Ltd., 1948.) 25*s*. net.

THERE is a special fascination and charm about the birds of the northern parts of the British Isles. The very names, 'whimbrel', 'black-throated diver', 'greenshank', and so on, seem to have a peculiar appeal. In this account of his experiences on the mainland of Scotland and in Shetland, Capt. Yeates conveys this fascination to the reader. He writes of birds and bird matters in a pleasant and informative manner, illustrating his text with many photographs. Bird photographers to-day are legion, and they vary much in skill ; but Capt. Yeates is among the leaders in this branch of the photographer's art, and the 115 reproductions in black and white are good examples of his work, all being excellent, and many fine. In addition there are two reproductions in colour from 'Kodachrome' originals and two plates from paintings by Mr. G. E. Lodge. Colour photographs and paintings do not always bear comparison, the work of the brush generally winning from the artistic point of view ; but in this case all the pictures are admirable, the 'Kodachrome' reproductions being accurate in colour rendering and at the same time soft and harmonious. As for Mr. George Lodge's pictures, it suffices to say that they are what we have long learnt to expect from this skilled painter of birds, fine colour effects being combined with great accuracy of plumage detail.

FRANCES PITT

# GENETICS IN THE SOVIET UNION

By Prof. ERIC ASHBY
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SINCE last August there have been reports in the Press of a crisis among biologists in the U.S.S.R. The crisis culminated in a decree from the Præsidium of the Academy of Sciences, published on August 27. This decree dismisses a number of prominent biologists from their posts, closes two famous laboratories, and removes orthodox geneticists from committees and editorial boards of the Academy. The Press reports have not been complete or objective; and the only full accounts of the crisis have been in the Russian language. British biologists will be grateful, therefore, to the Commonwealth Bureau of Plant Breeding and Genetics, which has now brought out a summary[1] of the conference which led to the crisis, from articles in *Pravda* over the first three weeks of August. At the same time, an English version of Lysenko's speech at this conference has been published under the auspices of the Society for Cultural Relations with the Soviet Union[2]. These two documents, together with an essay published by the Bureau of Plant Breeding two years ago[3], and an illustrated account of Lysenko's experiments[4], provide the British reader with adequate data to interpret the recent decree of the Academy of Science.

The Lenin Academy of Agricultural Sciences, of which body Lysenko has been president for ten years, held a Conference during July 31–August 7 of this year. It was reported that several new members had been elected to the Academy, all 'Michurin-biologists'; Lysenko delivered a presidential address of some nineteen thousand words; and there was a long discussion in which many members took part. After Lysenko had spoken it was revealed that his address had been previously examined and approved by the Central Committee of the Communist Party.

Lysenko's address[2] follows familiar lines. It contains a re-statement of the antithesis between so-called Mendelism–Morganism and the new Soviet genetics based on Michurin. It denies the chromosome theory of heredity. It arraigns several Soviet biologists because their work is inconsistent with Marxist ideology and is sterile of practical results: M. M. Zavadovsky, because he admires Morgan; I. I. Schmalhausen, because his theory of stabilizing selection is "profoundly wrong ideologically" and has "a disarming effect upon practical activity"; A. R. Zhebrak, because his work on wheat polyploids has "produced literally nothing of practical value"; N. P. Dubinin, because the work on population genetics (upon the strength of which Dubinin was elected a corresponding member of the Academy of Sciences in 1947) is of no practical importance; and so on. Lysenko complains that the work of his school has been suppressed by the Academy, the Ministry of Agriculture, and the Ministry for Higher Education. He attacks the universities for using as their genetics text a book by the Americans Sinnott and Dunn. He explains that Michurin biologists will no longer be in a minority in the Agricultural Academy, "thanks to the interest taken in it by the Party, the Government, and Comrade Stalin personally". He then proceeds to give an outline (the clearest yet published in English) of his methods of "shattering" heredity by graft-hybridization and by partial vernalization. The mainstay of his evidence is still the experiments of Avakyan and Yastreb[5], which were discredited in 1944. The objective of Lysenko's attack on Mendelism is not so much its false ideology, but rather its impotence. By insisting on the stability of the germ plasm Mendelism "condemns practical workers to fruitless waiting". The inheritance of acquired characters is a doctrine necessary for the progress of Soviet agriculture.

Lysenko's speech was followed by a discussion which has been ably summarized by the Commonwealth Bureau[1], and which makes fascinating reading. There is a chorus of testimony to the efficacy of Lysenko's methods, a renewed insistence on utility as the test of a scientific theory, and a condemnation of Mendelian geneticists in the U.S.S.R., mainly on the grounds that they are wasting time. Dubinin's work, for example, is described by Yakuskin as a monstrous deviation from the tasks of a Soviet scientist, and by Mitin as "unpatriotic". The State Seed Committee is criticized for insisting that new varieties should be homozygous. The Academy is criticized because its three biological journals have refused to accept papers on Michurin biology, and the University is criticized for turning down some doctors' theses on Michurin biology.

These contributions to the discussion make it abundantly clear that before last August biologists in the U.S.S.R. were free to work and publish and teach orthodox genetics, and that the Academy of Sciences, and the Ministries of Agriculture and Higher Education, were putting some of their weight, at any rate, on the side of Mendel and Morgan. Nor, even last August, had the orthodox geneticists been silenced. Nemchinov, Zhebrak, Rapoport, Alikanyhan, Zhukovsky, Schmalhausen, all defended their views against Lysenko's attack, though some of them made declarations of a change of their views at the end of the session. Clearly there is now, for the first time, a 'party line' on questions of biology in the Soviet Union.

About three weeks after this Conference the Academy of Sciences of the U.S.S.R. met, and adopted the new party line on biology. As a consequence of this, the Biological Section of the Academy has had to be reorganised, and this is the purpose of the decree of August 26, which is translated in full by the Commonwealth Bureau of Plant Breeding and Genetics. The effect of the decree is to bring to a stop many lines of work which had earned the admiration of biologists all over the world: Dubinin's studies on population genetics; Schmalhausen's work on natural selection; the work of Zhebrak on colchicine-induced wheat polyploids, of Sacharov on buckwheat polyploids, of Navashin on chromosome structure; and the splendid genetics course built up by Serebrovsky in the University of Moscow, with its thorough training in biometry, will have to be scrapped. Michurin-genetics, which has hitherto been up against a 'non-co-operation policy' from the leaders of biology in the U.S.S.R., now has a clear field.

Many biologists outside the U.S.S.R. will react with indignation to these events; for science as a

whole is the poorer by the elimination of these admirable schools of genetical research in the U.S.S.R. Earlier crises in Soviet science have been so inadequately reported that it was difficult to form a sound judgment as to what had happened. On this occasion we have a good record of the facts.


[1] *Plant Breeding Abstracts*, **18**, No. 2,000. Commonwealth Bureau of Genetics and Plant Breeding (1948).

[2] Lysenko, T. D., "Soviet Biology: a Report to the Lenin Academy of Agricultural Science, Moscow, 1948". Birch Books, Ltd., London (1948).

[3] Hudson, P. S., and Richens, R. H., "The New Genetics in the Soviet Union" (Cambridge, 1946).

[4] Ashby, E., "Survey of Botany in the Soviet Union. Report of 25th Meeting of the Australian Association for the Advancement of Science, 1940", 245–266 (1948).

[5] Avakyan, A. A., and Yastreb, M. G., "Hybridisation through Grafting", 50 (Yarovizatsia, 1941).


# PARBOILING TREATMENT OF RICE


By Dr. J. J. C. HINTON

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THE pre-milling treatment of paddy known as parboiling, involving treatment of the unhulled rice with hot water and steam, is established commercial practice, and for some time considerable attention has been paid to this and similar methods which aim at improving the nutritive value of rice; these latter include 'conversion' processes in which the steam is applied under pressure, sometimes preceded by a stage when the paddy is held under partial vacuum. Reviews of the subject have been prepared by the Economic Advisory Council, London[1], and the U.S. National Research Council, Washington[2]. These treatments result in a higher content of water-soluble nutritional factors, particularly those of the B group of vitamins, in the milled rice. It has been generally accepted that this is due to a redistribution of the nutrients within the grain, so that the endosperm is considerably enriched.

The distribution of vitamin $B_1$ within the rice grain is very similar to its distribution in wheat[3], and 45–50 per cent is found in the scutellum[4]. Furthermore, Nicholls has recently observed that, in contrast to untreated rice, in most samples of parboiled and converted rice the scutellum portion of the germ appears to remain in the grain after milling, and he has suggested that the explanation of the effect of pre-treatment may be found in this fact rather than in the re-distribution of nutrients[5]. The present article describes some experiments bearing on this interesting suggestion.

## Parboiling and the Distribution of Vitamin $B_1$

Vitamin $B_1$ is readily assayed and may be taken as an index of the behaviour of the other soluble nutrients. An examination of the vitamin $B_1$ distribution was carried out on grain freshly treated on a laboratory scale. A conversion method of treatment, known as the Malek process, was used, small samples of paddy being heated in water at 75° C. for 4 hours, roughly dried on a cloth, and steamed at a pressure of 15 lb. per sq. in. for 15 min. 15–20 grains were dissected by first removing the embryo and scutellum. The end of the grain was then cut off, and the pericarp, aleurone layer and endosperm removed from the centre portion of the grain. The outermost layer, amounting to 15–20 per cent of the endosperm, is described as endosperm 1, and the remainder as endosperm 2. The vitamin $B_1$ content of these portions was determined by the microthiochrome method[6] and expressed on an air-dry basis of approximately 12 per cent water content. The results of several experiments are given in Table 1.

Table 1. Vitamin $B_1$ content (I.U. per gram) of parts of the rice grain untreated and converted by a parboiling process

| Sample | Embryo | Scutellum | Pericarp-aleurone layer | Endosperm 1 | Endosperm 2 |
|---|---|---|---|---|---|
| 1. Untreated grain | 23 | 63 | 10·5 | 0·45 | 0·10 |
| 2. 4 hr. after parboiling | 5·9 | 0·4 | 0·5 | 0·56 | 0·32 |
| 3. 4 hr. after parboiling | | | 0·6 | 0·54 | 0·44 |
| 4. 72 hr. after parboiling | nil | nil | 2·3 | 0·73 | 0·44 |
| 5. 12 days after parboiling | nil | nil | 0·9 | 0·40 | 0·10 |
| 6. 4 hr. after parboiling | 21·4 | 11·2 | 3·6 | 0·88 | 0·22 |
| 7. Heated to 75° C. for 4 hr., not steamed | 24·4 | 30·7 | 6·2 | 0·80 | 0·20 |
| 8. 12 hr. after parboiling | 3·2 | 2·1 | 0·65 | | |
| 9. 23 days after parboiling | 5·3 | 2·8 | 0·77 | | |
| 10. 23 days after parboiling | 6·4 | 3·8 | 0·71 | | |

Excepting sample 5, all the samples show redistribution of vitamin $B_1$ in varying degree; the endosperm, particularly the outer endosperm, is enriched while the normally rich parts of the grain are impoverished. An analysis of the endosperm immediately in contact with the scutellum was also carried out, and the results are given in Table 2.

Table 2. Vitamin $B_1$ content of germ and adjoining endosperm in raw and parboiled rice

| | Germ (scutellum and embryo) | | Endosperm | |
|---|---|---|---|---|
| | Weight (mgm.) | $B_1$ (I.U. per gm.) | Weight (mgm.) | $B_1$ (I.U. per gm.) |
| 1. Untreated | 8·7 | 44 | 13·5 | 0·44 |
| 2. Parboiled | 6·3 | 9·5 | 12·3 | 5·2 |
| 3. Parboiled | 5·7 | 8·7 | 15·8 | 4·6 |

The figures reveal appreciable movement of the vitamin $B_1$ from the germ into the endosperm in the parboiled samples.

There are well-marked differences in the results of the tests shown in Table 1. Thus in numbers 4 and 5, no vitamin $B_1$ remains in the embryo or scutellum, and though there has been some re-distribution in 4, there is a total loss of about 75 per cent of the vitamin $B_1$, while there was no re-distribution in 5 and a total loss of 89 per cent. These samples were dissected some time after being treated; but the loss is not due solely to this storage period, as is shown by 9 and 10, which are sub-samples of 8 dissected 23 days later. Again, in sample 6, there has been little reduction in vitamin $B_1$ in the embryo and about 20 per cent of the original remains in the scutellum. Samples 2, 3, 8, 9 and 10 are between these two extremes of behaviour.

These differences were investigated further by examining the behaviour of dissected germ under the conditions of treatment of the paddy, and the conclusion was reached that they were probably due to the presence of a variable amount of water of

condensation during the steaming stage. On the other hand, it seems likely that the presence of some free water during steaming is essential for effective re-distribution. The data obtained by examining the dissected germ portions (obtained from a sample of rice different from that of Table 1) are shown in Table 3 and will be discussed with those in Table 1.

Table 3. Vitamin $B_1$ in dissected rice germ subjected to various treatments

| Sample of germ | Embryo (I.U. per gm.) | Scutellum (I.U. per gm.) |
|---|---|---|
| Control | 31 | 45 |
| 1. Steamed in plugged tube. (Largely out of contact with steam) | 21<br>20 | 20<br>21 |
| 2. Steamed on filter paper | 16<br>13 | 20<br>21 |
| 3. Steamed on watch glass | 1·5 | 2·0 |
| Liquid in watch glass equivalent to | 13·0 | 24·0 |

For the steaming treatment in the samples described in Table 1, small samples, 5–10 gm., of paddy were spread out on a clock-glass, filter-paper or an open beaker. When a clock-glass or beaker was used, considerable water of condensation was present; in tests 4 and 5 the grain swelled and burst, while in addition some liquid water remained on the clock glass in test 5. Samples 2, 3, 8 and 9 were spread on filter paper which would absorb most of the water of condensation; in these samples much less grain-swelling occurred and there was only slight opening of the hulls. It thus seems that heavy loss of vitamin $B_1$ from the germ is coincident with the presence of an excessive amount of water of condensation. The behaviour of the dissected germ in Table 3 supports this conclusion; steamed on filter paper, there is a reduction of about 50 per cent; steamed on a watch-glass, there is a reduction of about 95 per cent, but about 45 per cent was recovered from the condensate on the watch-glass, leaving an overall loss of about 50 per cent as before, which is probably due to thermal destruction of vitamin $B_1$.

Sample 6 of Table 1 was steamed in a flask plugged with cotton-wool; steam would reach the inside more slowly and condensation on and around the grain might be completely prevented. There was no obvious swelling and opening of the hulls, and the paddy was scarcely altered in appearance. There is very much greater retention of vitamin $B_1$ in the germ, the embryo showing almost its original value; while at the same time the re-distribution is less than 3 and 4, shown most markedly in the inner endosperm. The behaviour of the dissected germ (Table 3, sample 1) is broadly in agreement with this, the difference in behaviour of scutellum and embryo, however, being less marked.

In sample 7 steaming was omitted, and the vitamin $B_1$ is re-distributed to about the same degree as it is in 6, suggesting that the temperature of the steaming treatment alone has no effect on re-distribution.

These results suggest that re-distribution is determined mainly by the entry into the grain, as the starch gelatinizes, of a small amount of water condensed on its surface. The effect of the preliminary air exhaustion in, for example, one patented process known as the H.R. Conversion Process, may be to introduce water between the hull and the grain in addition to, or instead of, water of condensation. A great excess of water such as was present in some of the experimental tests led to almost total loss of vitamin $B_1$, while in the absence of sufficient water effective distribution did not take place.

It is to be noted that in these experiments the scutellum was more sensitive to the steaming treatment than the embryo, and that a considerable proportion of the vitamin $B_1$ of the germ and aleurone layer was not re-distributed but lost, at any rate as measured by the thiochrome method. In sample 4, about 75 per cent of the total vitamin $B_1$ was lost, and in samples 2, 6 and 9 about 50 per cent. Figures in the literature for rice prepared in a commercial conversion plant indicate a loss of about 20 per cent.

## Parboiling and the Retention of Germ

(*a*) The residual germ, which was mainly scutellum, was dissected from the samples shown in Table 4 and the vitamin $B_1$ determined in the germ and grain. These samples had been parboiled and milled on normal commercial machines to produce the usual form of polished rice. The age of the four samples was unknown.

Table 4. Germ and vitamin $B_1$ contents of samples of milled rice

| Sample | Grain: Vitamin $B_1$ content (I.U. per gm.) | Germ: Vitamin $B_1$ content (I.U. per gm.) | Germ: Proportion of the grain by weight | Germ: Percentage of total $B_1$ of grain |
|---|---|---|---|---|
| Parboiled No. 1 | 0·40 | 1·0 | 0·4 per cent | 1·17 |
| ,, ,, 2 | 0·60 | 0·9 | 0·45 ,, | 0·67 |
| ,, ,, 3 | 0·65 | 0·84 | 0·34 ,, | 0·44 |
| Raw | 0·20 | 22·0 | 0·07 ,, | 7·7 |

The three parboiled samples have a higher vitamin $B_1$ content and a much higher germ content than the raw sample. The $B_1$ content of the germ of the parboiled sample, however, is very low and contributes only about 1 per cent of the total vitamin $B_1$ of the grain. On the other hand, the small amount of germ left in the raw sample has a much greater vitamin $B_1$ content and contributes much more to the vitamin content of the grain.

(*b*) A second series consisting of samples taken at various stages of milling was examined. The treated samples had been prepared by a conversion process, and all the samples had been milled by normal commercial methods. There was very little difference between the vitamin $B_1$ content of the milled converted rice and milled raw rice, and the full data are therefore not presented in Table 5.

Table 5. Germ content and vitamin $B_1$ content of converted and raw rice

| | Raw | Converted |
|---|---|---|
| Germ content of the milled rice | 0·1 per cent | 0·08 per cent |
| Per cent of grains containing some germ | 6·0 ,, | 90·0 ,, |
| Average germ content of grains which contain germ | 1·71 ,, | 0·09 ,, |
| | Vitamin $B_1$ content (I.U. per gm.) | |
| Hulled rice | 1·38 per cent | 0·48 per cent |
| Milled rice | 0·43 ,, | 0·49 ,, |

The vitamin $B_1$ content of the milled raw rice is rather high, but is within the range reported in the literature; the $B_1$ content of the converted rice is low. No direct determinations were made on the germ; but the low vitamin $B_1$ content of the germ of the converted sample can be inferred from the low figure found for the converted hulled rice. The germ content in each of the milled samples is very low, the

converted sample being lower than the raw sample. There is, however, an important point brought out in the figures. Only 6 per cent of the raw grains contained any germ, and those that did had an average germ content of 1·71 per cent. 90 per cent of the converted grains contained some germ, though the average germ content of each grain was only 0·09 per cent. Thus the germ content of the raw sample as a whole is due to a few grains which have completely missed the action of the milling machine, and contain almost the entire germ, while the great majority of the converted grains retain some germ, but this is much reduced in amount by heavy milling.

Another sample of converted rice from the same mill showed similar characteristics. 100 per cent of the grain contained some germ, but the germ content of the sample was only 0·05 per cent. Each of these samples appeared to have been heavily milled.

The suggestion that parboiling causes germ retention in milled rice is strongly supported by these results. A close examination of raw and freshly parboiled rice gives the reason. In cereal grains the scutellum is separated from the endosperm by a membrane formed by the walls of a layer of empty and crushed cells. In the rice samples so far examined, unlike wheat, for example, the endosperm in close contact with this membrane is loose and powdery, providing very poor adhesion. Normally, the skin layers and aleurone layer seal and hold the germ in the grain. The process of milling quickly removes the outer layers and the germ is then very readily dislodged; and this is what occurs in the samples of raw rice, the germ being lost not by rubbing down but by being knocked cleanly out of the grain.

Parboiling partially gelatinizes the endosperm, the powdery nature of the part in contact with the membrane is changed and adhesion is now extremely good so that the germ is not readily knocked out. There is also a slight toughening action on the germ itself, but this is not sufficient to prevent considerable loss if the grain is heavily milled.

## Discussion and Conclusions

The large-scale processing of rice is not yet carried out in Great Britain. For this reason samples freshly prepared by commercial methods and otherwise of known history were not available for this work. Nevertheless, the experiments confirm that a parboiling or conversion treatment does lead to a re-distribution of vitamin $B_1$ in the grain, with the result that the endosperm is considerably enriched. Furthermore, there is an indication (sample 7 in Table 1) that simple steeping in hot water alone results in a measure of enrichment of the endosperm with vitamin $B_1$. However, it seems very probable that the maximum re-distribution is dependent upon water condensing, or being otherwise present, on the surface of the grain and entering into the gelatinizing endosperm. Under these conditions, vitamin $B_1$ is more or less rapidly lost from the germ.

The experiments also confirm the suggestion by Nicholls that there is a marked retention of the scutellum in milled parboiled rice as compared with milled raw rice, due largely to gelatinization of the endosperm immediately beneath the germ, which acts as a cementing layer so that the germ is not so readily knocked out or dislodged during the subsequent milling. It is not yet clear, however, how far this retention of germ is responsible for the higher vitamin $B_1$ content of rice milled after a parboiling treatment. This will depend upon the conditions of the treatment, that is, probably the amount of free water associated with the grain when gelatinization occurs. This in turn will largely determine the amount of vitamin $B_1$ retained in the germ. The fact, however, that the germ is not so readily dislodged from such grain does indicate the need for experiment on how far the type or severity of the milling process and the detailed conditions of pre-treatment influence the quality of the final product. Clearly a high content of germ is desirable, apart from considerations of vitamin $B_1$ alone.

It would be of interest, for example, to study the effects of mild soaking in hot water (as in sample 7, Table 1) followed by light milling as an alternative to a boiling or steaming treatment followed by heavier milling, since this soaking had improved the adhesion of the germ by partially gelatinizing the endosperm beneath without seriously reducing its vitamin $B_1$ content.

I am indebted to Dr. Lucius Nicholls and Dr. C. W. Herd for the samples of rice.

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# THE FIGURE OF THE EARTH*

By Prof. HAROLD JEFFREYS, F.R.S.

ANY departure of the earth's external gravitational field from symmetry affects several geophysical and astronomical phenomena, especially observed gravity, the form of the level surfaces, which are normal to the direction of gravity, and perturbations of the moon, of which two are secular and one has a period of a month. There is a formal theory connecting them, which amounts to saying that if $\Psi$ is the geopotential, defined by

$$\Psi = U + \tfrac{1}{2}\omega^2 r^2 \cos^2\varphi',$$

where $U$ is the gravitation potential, $\omega$ the rate of rotation, $r$ the distance from the centre of mass, and $\varphi'$ the geocentric latitude, then $\Psi$ is a constant $C$ over the ocean surface, and gravity is the inward normal component of the gradient of $\Psi$. If the ocean covered the whole surface, observations of gravity over it would suffice to determine its form and the complete external field. The problem is different from those in potential theory, where we are told the form of a surface and either the potential or its normal gradient over it, and we have to find the other. Here we are told a lot about both the potential and the normal gradient, and have to find the form of the surface. The problem was solved to the first order by Stokes and to the second by Helmert.

The chief complication, of course, is that $\Psi$ is not constant over the outer surface; but this was dealt with by Stokes. The point is that if $h$ is the measured height, $\Psi = C - gh + O(h^2)$; and the observations thus refer to a surface where $\Psi$ is known (apart from an additive constant) but is not constant. But if we form $g_1 = g(1 + 2h/a)$ and take gravity equal to $g_1$

* Substance of a paper at a Geophysical Discussion on October 22.

over a surface $\Psi = C$, the solution is practically identical with the correct one at points outside the earth and therefore gives the external field correctly. This is the free-air reduction. It plays such a fundamental part that we may say outright that there is no other way of allowing for variations of height above sea-level if we are to get the external field right. We cannot remove the effects of elevated matter on the field, and any process such as isostatic reduction that attempts to do so is simply a way of introducing systematic error.

When we try to use free-air values there is a difficulty, because in irregular country they vary irregularly and show a strong positive correlation with height. To represent a region properly, we want the mean free-air gravity over it, and therefore an estimate for the mean height of the region. Thus we have to take $g_1 = \alpha + \beta h$, find $\alpha$, $\beta$ by least squares, and use the solution to find $\alpha + \beta\bar{h}$, where $\bar{h}$ is the mean height of the region (*not* that of the stations, which have a way of being in valleys). I maintain that this is the only way of presenting gravity summaries that does not introduce systematic error or give a spurious appearance of accuracy. $\beta$ is not the same in all regions; and over the ocean $h$ must be replaced by the depth, and the solution must be adapted to mean depth. A reason often given for using isostatic anomalies* is that they are more regular than the free-air ones; but in most regions they are not appreciably more regular than the free-air ones with allowance for height, and the exceptions are precisely those where there is most risk of systematic error in using them.

When this method was applied to gravity, it was found convenient to classify the observations over 10° squares and get a mean value for the free-air anomaly for each. The means were found to show considerable irregularity, decidedly more than the apparent uncertainties will explain. Consequently it is useless to try to treat values for, say, 1° squares as subject to independent errors—there is a strong correlation of residuals at stations up to 10° apart and an appreciable one up to 30°. I speak of these as the $\tau_1$ and $\tau_2$ variations. Over and above the apparent uncertainty based on the departures for 1° squares from the mean, the 30° squares show a variation representable by a standard error $\tau_3$ of about 15 mgal., and the 10° ones show one, with reference to the 30° means, of $\tau_1 = 21$ mgal. These should be right to about 2 mgal., and must be considered established. The values show no correspondence with mean heights of the squares, whereas any form of isostasy suggested would leave a positive correlation. The 'added mass' theory is, of course, worse; but we have reached a stage where further progress requires analysis of the residuals, and the isostatic theory gives us no help in understanding them. Isostasy must be regarded as a rough approximation for special regions where irregularity of height is extreme, and not even for all of them.

Even between adjacent 30° squares there is some correlation of the residuals. This could be due in part to errors of comparison of base stations. Assuming it genuine, I found four spherical harmonics in gravity of degrees two and three with longitude factors, and apparently significant amplitudes, besides small corrections to the mean and the main ellipticity term, but I should not like to be sure of them because some of the distant comparisons are under suspicion. The 10° and 30° variations, however, depend chiefly on comparisons with one base station common to each square and should be little affected by such errors.

The measurement of the radius and ellipticity of the earth by geodesy is essentially a matter of comparing the variations of latitude or longitude along an arc of measured length. As direction is measured by means of the plumb line, any irregularity of direction of gravity will be thrown into the latitudes and longitudes and produce errors in the results. In fact, it is known that residuals in surveys tend to maintain sign over considerable distances, and in some cases estimated uncertainties have been increased accordingly. But we now know a bit more; we still do not know the deflexions in detail, but we have a good idea of their average amount, because in a potential disturbance of high order the mean squares of the two transverse components are together nearly equal to that of the radial component, which we know from the irregularities of gravity. The uncertainty thus becomes calculable; the 10° and 30° variations together will produce an increase of the uncertainty of an estimate of the radius ranging from about 800 metres for a 10° arc to 280 metres for a 30° arc and 66 metres for a 100° arc. I had considerable difficulties in tracing the original determinations; but the outstanding result was that, with the apparent uncertainties found from the survey residuals, the results were plainly discrepant: $\chi^2 = 15{\cdot}3$ on 6 d.f.† But with an increase of uncertainty due to deflexions, $\chi^2$ came down to 4·4 or 2·4 according as the low harmonics in gravity were allowed for or not. The solution then indicated that Hayford's radius was too large; the equatorial radius was $6378{\cdot}117 \pm 0{\cdot}119$ km. in both cases, Hayford's value being 6378·388 km.

The absolute value of gravity has been redetermined twice lately, at Teddington and Washington, and various cross-comparisons have indicated that the Potsdam determination of $981{\cdot}274 \pm 0{\cdot}003$ cm./sec.² is 10–20 mgal. too high. It appears that the Potsdam workers had corrected for a systematic error that was not there. With a method of reduction that takes account of internal correlation of the errors, I get $981{\cdot}2633 \pm 0{\cdot}0022$. The three absolute measures, with three cross-comparisons, give

$$g_P = 981{\cdot}2606 \pm 0{\cdot}0010;\ g_T = 981{\cdot}1807 \pm 0{\cdot}0008;\ g_W = 980{\cdot}0831 \pm 0{\cdot}0009.$$

$\chi^2 = 6{\cdot}2$ on 3 d.f. This is slightly on the large side, but not large enough to afford reason against taking the experimental determinations at their face value. The principal British stations are strongly connected with Teddington by recent measures made by the Anglo-Iranian Oil Co. with a gravimeter. Apparently the solution requires all absolute determinations, which are mostly based on the Potsdam standard, to be reduced by about 13 mgal.

If the interior of the earth was in a hydrostatic state, the ellipticity could be found from the precessional constant with a standard error of about 0·08 in the denominator. No other method makes this less than about 1. The hypothesis is certainly false, but the existence of the 10° and 30° variations gives an indication of how far it is likely to be wrong; the effect is to increase the estimate of uncertainty to about 0·31 or 0·61 according as the low harmonics in

*An anomaly is the excess of gravity over that given by the international formula, which is an approximate formula that makes the surface $\Psi = C$ an exact spheroid of ellipticity 1/297·0.

†"d.f." means "degrees of freedom", which is number of estimates less number of parameters found from them. $\chi^2 = \Sigma(O - C)^2/s^2$, where $s$ is the standard error of the estimate $O$.

gravity are rejected or accepted. In either case, contrary to what I had expected, it remains the most accurate single equation for the ellipticity.

The lunar parallax has been measured visually, and can also be calculated. Very crudely, $g_0 = fE/a^2$, $n^2 = fE/r^3$; whence $an^2/g = a^3/r^3$. ($f$ is the constant of gravitation; $E$ is the mass of the earth; $a$ is the radius; $n$ is the moon's angular velocity; $r$ is the moon's distance.) Several corrections are needed, and when they are made the result is the dynamic parallax. There has been a slight discrepancy between the visual and dynamical values, but as it was only about 1·4 times the standard error it does not, in any event, appear serious. Here again the possible deflexions of the vertical at Greenwich and the Cape must be taken into account. The final result is that all the data, survey ($a$ and $e$), the main ellipticity term in gravity, the lunar parallax, and the estimate of the ellipticity from the precessional constant fall nicely into agreement with regard to the uncertainties, whether the longitude terms of low degree in gravity are accepted or not. All the discrepancies can be explained as due to the earth's having been treated as more symmetrical than it is.

The data for the moon's motion have been combined with those for the earth. Again no discrepancy was found; altogether $\chi^2 = 6·3$ or $8·7$ on 14 d.f. The final results in a compromise solution are

$a = 6378·099 \pm 0·116$ km.; $e^{-1} = 297·10 \pm 0·36$.
$g = g_e(1 + \beta \sin^2\varphi + \gamma \sin^2 2\varphi)$;
$g_e = 978·0373(1 \pm 0·0000024)$; $\beta = 0·0052891 \pm 0·0000041$; $\gamma = -0·0000059$;
Lunar parallax $= 3422·419'' \pm 0·024''$;
Mass of earth/mass of moon $= 81·278 \pm 0·025$;
Precessional constant $= 0·00327260 \pm 0·00000069$.

Except for $a$ and $g_e$, there is no serious change from accepted values, but the uncertainties are based on additional evidence and more satisfactorily determined.

# OBITUARIES

## Mr. Richard Elmhirst

RICHARD ELMHIRST died very suddenly on November 13 at Millport after forty-two years of service to the Scottish Marine Biological Association and within a few months of the date when he would have retired. He was the youngest son of the Rev. Robert Elmhirst, vicar of Brotherton, in Yorkshire, and was educated at St. George's School, Harrogate, and at Rossall School. There the bent of his mind was early displayed; he was twice natural history prizeman and was assistant curator of the School museum. In 1902 he proceeded to the Yorkshire College, which had become the University of Leeds before he left in 1905. He took no degree, maintaining throughout life an objection to degrees or appendages of any kind, but with his natural gifts fortified by study under that great teacher and zoologist, L. C. Miall.

Elmhirst had already had experience of museum work at Leeds and at Keighley when he went to Plymouth in January 1906 to undertake, for the Marine Biological Association, the preparation of a collection of marine exhibits for the exhibition held that year at Marseilles. He returned from France to take up an appointment in September as naturalist at Millport on the recommendation of E. J. Allen. It was at Millport that he was to do his life's work. On the resignation of the director, S. Pace, in 1907, he was appointed interim curator, promoted superintendent in 1908 and finally director in 1933. He served with distinction in the First World War as lieutenant, R.N.V.R., in the Dover Patrol.

From 1907 until 1922 Elmhirst was the sole member of the scientific staff at Millport. He had little to maintain him but his enthusiasm as a naturalist in the midst of a wonderful collecting area of sea and shore. Later he had the satisfaction of seeing the Station develop with a fine extension to the buildings in 1939, and even the setbacks of the Second World War made good by major increases in staff and equipment.

Richard Elmhirst was a born naturalist and a most lovable man; and because he was so interested in all living things, his fellow creatures as well as the inhabitants of the shores of the Great Cumbrae and of the waters of the Clyde Sea area, he was a fine teacher. He enjoyed the annual Easter classes where so many students had their introduction to marine biology. I myself must be one of many whose interests were permanently influenced by studying the seashore and its life under his guidance. It was the same with all visitors. He welcomed them with natural hospitality and would go to endless pains to secure the most unlikely of animals, and with a success that brought him as much pleasure as it did the recipient. The Millport laboratory has a tradition of popular teaching, and annually all manner of parties from natural history societies, colleges and schools came—and usually on Saturday afternoons—to be welcomed by him and given lectures and demonstrations or taken for expeditions on the shore. He was known throughout the west of Scotland as a willing and always interesting lecturer.

He never confined himself to any particular group of animals. He knew them all, and the plants as well. The very diversity of his interests was in one sense a drawback. There were so many fascinating things to observe and to investigate that when he had examined one thing he must proceed at once to another and then another. So his published papers, though far-reaching and all of real value, were never so full or so detailed as they would have been had he confined his interests more rigidly. But if he had done so he would never have acquired his amazing breadth of knowledge—and he would not have been Richard Elmhirst.

It was as a man that we remembered him when he was laid to rest on November 16 at Millport, with which his name will be associated so long as the marine station which he built up survives. Our heartfelt sympathy goes out to Mrs. Elmhirst and to his son.

C. M. YONGE

## Dr. S. C. Bradford

THE death on November 13 of Dr. S. C. Bradford, following so closely on that of Prof. A. F. C. Pollard, suggests that the elder generation of those who built up the modern scientific information network is passing away, its contribution made.

Samuel Clement Bradford was born in London in 1878, and joined the staff of the South Kensington Museum in 1899, being in the library from 1901 onwards. He worked at this time in what is now the Victoria and Albert Museum. During 1911–14 he had charge of the chemistry collections in addition

to his work in the library. During the First World War he was lent first to the National Physical Laboratory and then to the Chemical Warfare Department. He became chief librarian of the Science Library in 1925, with the rank of keeper from 1930. He married Cora Mabel Monnery, who survives him. He leaves no children.

It may well have been Bradford's experience of literature searches during the First World War which led to the activities for which he is remembered. At all events, he proceeded to develop the Science Museum Library as the nucleus of a great central information service, with a vast repository of cards classified by the Universal Decimal Classification. He became persistently active in propaganda for the decimal system, since the scheme would fall to the ground unless an international classification was widely adopted. The British Society for International Bibliography came into being largely through him. National and international meetings were held, culminating in the Oxford gathering of the International Federation for Documentation in 1938.

Meanwhile, one really successful development due to Bradford at South Kensington went on with no need of propaganda. This was the loan system, for after the First World War came the great development of research by industry and government, and this entailed a huge appetite for postal loans. This Dr. Bradford set himself energetically to satisfy. It is indeed ironical to think of the mechanized distributing centre planned from a room which in size and furnishings was one of the all too few survivals of a more spacious and humane conception of library work. It is as seated in this room that his friends will wish to think of him, the brown leather bindings behind the glass, the space bisected by a chemical bench. For Bradford was an active man of science as well as a bibliographer; colloids and the kinetic theory of liquids being among his subjects. Another of his activities will occur to many who met him: the choice rose so often to be seen in his buttonhole marked him for the very active fancier that he was. Music, also, had been an early interest. But basically he remained one of the older museum and library world, deeply concerned with the details of his profession.

Bradford's literary work included various official catalogues, including "Classification for Works on Pure and Applied Science", second edition, 1921; third edition, 1936; "Hand-list of Short Titles of Current Periodicals in the Science Library", fourth edition, 1926; fifth edition, 1938; "Romance of Roses"; "The Science of Rose Growing"; contributions to scientific and technical journals; papers on the kinetic theory of gases and liquids; the molecular theory of solution; colloid solutions; the formation and structure of jellies; the crystallization of gelatin; the Liesegang phenomenon; the classification and indexing of scientific literature; the principles of classification; the organisation of scientific bibliography; and library cataloguing. His final contribution in this last field was the book "Documentation", which appeared not long before his death.

H. T. PLEDGE

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We regret to announce the following deaths:

Dr. J. H. van der Bijl, F.R.S., chancellor of the University of Pretoria, on December 2, aged sixty-one.

Lieut. Oliver Burd, R.N., meteorologist, and Mr. Michael C. Green, general assistant, of the Falkland Islands Dependencies Survey, on November 8.

The Right Hon. J. H. Hofmeyr, chancellor of the University of the Witwatersrand, and president in 1928–29 of the South African Association for the Advancement of Science, aged fifty-four.

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# NEWS and VIEWS

## Industrial Health Research Board

The following have accepted the invitation of the Medical Research Council to serve as members of the Industrial Health Research Board during the next three years: Sir Frederic Bartlett, professor of experimental psychology, University of Cambridge (*chairman*); Sir Charles Bartlett, managing director, Vauxhall Motors, Ltd.; Prof. R. V. Christie, professor of medicine, University of London; C. R. Dale, Social Insurance Department, Trades Union Congress; Dr. A. N. Drury, director of the Lister Institute of Preventive Medicine; Sir Luke Fawcett, general secretary, Amalgamated Union of Building Trade Workers; Prof. T. Ferguson, professor of public health, University of Glasgow; Sir Claude Gibb, chairman and managing director, C. A. Parsons and Co., Ltd., Newcastle-on-Tyne; Prof. A. Bradford Hill, professor of medical statistics, University of London; Prof. Esther M. Killick, professor of physiology, University of London; Prof. R. E. Lane, Nuffield professor of occupational health, University of Manchester; Dr. A. Massey, chief medical officer, Ministry of National Insurance; Dr. E. R. A. Merewether, H.M. senior medical inspector of factories, Ministry of Labour and National Service; Dr. J. M. Rogan, Medical Research Council headquarters staff: Dr. Donald Stewart, chief medical officer, Austin Motor Co., Ltd.; Mrs. Joan M. Faulkner, Medical Research Council headquarters staff (*secretary*).

The Board is appointed by the Council to advise and assist the latter in that part of its research programme which relates to occupational health. The detailed consideration of research work is in the hands of scientific committees dealing with such subjects as occupational medicine, occupational physiology, occupational psychology, industrial pulmonary diseases, toxicology and statistics. These committees report directly to the Council for purposes of immediate action. The function of the Board itself is that of a reviewing body considering general policy with regard to research over the whole field.

## Esperanto and Science

The British Esperantist Scientific Association has been founded by a body of British scientific workers and technical experts who are interested in the use of Esperanto as an international medium for the discussion of scientific affairs. Before the War there existed an Internacia Scienca Asocio Esperantista; but this body, like so many others, disintegrated during the last ten years, and is only being reconstituted with some difficulty. 'BESA' (as the new Association is popularly called) is taking an active

part in this work; meanwhile, however, it also aims at arousing an interest among British men of science in the potential value of Esperanto for the exchange of scientific information and at creating in Great Britain a nucleus of workers who are themselves adepts in the use of the language for scientific purposes. Several of its members are engaged in the compilation of technical vocabularies in various fields—an essential task inasmuch as (though Esperanto has been in use for general purposes for sixty years) there is as a result of the interruption of normal communications in recent times a considerable need for the standardization of many new technical terms which have come into use during this period. The Association has also made informal contacts with Unesco and other international organisations with regard to the whole question of international language. Since its inception in February 1947, the Association (which has an advisory panel of distinguished workers in various branches of science) has held a number of meetings at University College, London. Business proceedings are conducted in English, but technical papers are read and discussed in Esperanto. Membership of the Association is open to all who are interested in the application of Esperanto to science and technology, whether professionally occupied in these fields or not. The president is Dr. J. C. Flugel, of University College, London, and the honorary secretary, Mr. E. D. Durrant, of 15 Beaufort Road, Reigate, Surrey.

## Vitamin D Assay

ALTHOUGH specification for the assay of vitamin $D_3$ by the chick method exists (London: British Standards Institution: B.S.S.911) there is none pertaining to assay on rats, the test animals used in many different laboratories. The Society of Public Analysts and Other Analytical Chemists, and the Society of Chemical Industry therefore set up a joint committee to determine "the fiducial limits that might reasonably be expected in biological assays of vitamin D using rats". British organisations employing this technique were asked to submit statements and opinions based on their own experience, and as a result of the information so collected the joint committee has now issued the following statement: "In the absence of any special circumstances, it is reasonable to expect that assays of vitamin D by the rat method in normal commercial practice should have fiducial limits (calculated to a probability level of 95 per cent) not wider than 60–170 per cent"; and the opinion is expressed that "the result of any assay conforming to these limits should be a commercially acceptable estimate of the true potency of the material assayed". Fuller details are being presented by the committee in the *Analyst* and in *Chemistry and Industry*.

## Geophysics in Finland

GEOPHYSICAL studies in Finland on truly scientific lines started early in the eighteenth century, a movement in which an 'invitation' of date 1723 from James Jurin, secretary of the Royal Society, to co-operate in meteorological observation, played a part. An account of the early history of Finnish geophysical studies appeared in 1935 in the first issue of a journal, *Geophysica*, published by the Geophysical Society of Finland, a body founded in 1926. Papers are read at its meetings; but the Society is not in the main a publishing body. *Geophysica* No. 1 (financed by a grant from lottery funds) included, however, three general articles besides the historical summary, and also thirty-six pages of summaries (by the authors) of Finnish geophysical papers published during 1930–34, giving a view (though incomplete) of the then recent Finnish activity in the subject. This view is now extended by the appearance in 1947 of *Geophysica* No. 2, which, like No. 1, is written wholly in English and German. Apart from two short articles on the Finnish Geodetic Institute, 1918–38, and the Isostatic Institute (subsidized, except during the War, by the International Association of Geodesy), the volume is devoted to authors' summaries of Finnish geophysical literature during the period 1935–44. An improvement on No. 1 is the inclusion of alphabetical lists of authors under five subject-headings, which makes the volume very convenient for reference in searching for any recent work done in Finland on these topics. The volume well indicates the extensive and valuable work done in geophysics in Finland during ten troubled years.

## Portable Barometer

A PORTABLE barometer made by the well-known clockmaker Daniel Quare (1649–1724) has been lent by Mr. R. Meyrick, of Corbridge-on-Tyne, to the Science Museum, South Kensington. The barometer is an early domestic form of the instrument, in which the tube and cistern are enclosed in a fluted walnut case carried on four metal feet. Thus the instrument can stand on a table, though a ring is also provided for hanging it against a wall. This barometer was the first designed for portability, having been made by Daniel Quare to his own patent specification of 1695. It uses a cistern with a flexible leather bottom which can be compressed by means of a screw so as to fill the barometer tube with mercury and thus avoid the risk of damage when the barometer is moved. To reduce this risk still further, there is a constriction near the top of the tube, to retard the flow of the mercury and thereby reduce the impact of the column on the upper, closed end of the tube. The instrument has a weather scale very similar to that still used on domestic barometers.

## An Interesting Hemipterous Insect from New Zealand

IN the first volume of *Dominion Museum Records in Entomology* (Wellington, N.Z.), June 1948, p. 63, Carl J. Drake and J. T. Salmon contribute a short paper entitled "A Second *Xenophyes* from New Zealand". Under the name of *Xenophyes forsteri*, the authors describe a new species of the small and little-known family Peloridiidæ from New Zealand. The family, it may be added, is also known from southern Argentina, Patagonia, Australia and Tasmania. It provides, therefore, an additional link in the evidence from other sources of a direct land connexion between the South American and Australasian continents. Only seven species grouped under three genera of Peloridiidæ are at present known. What little biological evidence there is available indicates that its members feed largely, or wholly, on mosses, and inhabit damp situations. The family was originally placed in the Hemiptera – Heteroptera and, since the antennæ are concealed from view, it was relegated to the series Cryptocerata. Recent research, however, indicates that its affinities lie with the suborder Homoptera and that it represents a separate and new series named by Myers and China in 1929 the Coleorrhyncha. This view is now generally accepted by most students of Hemiptera. The species are all

very small creatures the hind wings of which are vestigial or absent. The tegmina occur in probably all the species in two forms, macropterous and brachypterous, although both these types have not yet been found in all cases.

## The Solar Apex

MR. O. R. WALKEY has examined the literature on the position of the solar apex (*Mon. Not. Roy. Astro. Soc.*, **106**, No. 4; 1946). Table 1 shows the marked divergences in the positions determined from 1933 to 1941. Mr. Walkey uses as his basis Moore's "Catalogue of Radial Velocities" (*Pub. Lick Obs.*, 18; 1932) and Boss' "General Catalogue" (*Carnegie Pub.*, No. 468; 1937). It is suggested that the divergences just referred to may be partly due to rotation in a probable local cluster which leavens the allowance made for galactic rotation—a view to which some support is given by the increased declination in the apex with increased magnitude of the stars used. Mr. Walkey believes that our ignorance of the actual peculiar motions of the stars, and the consequent assumptions required to fill this gap in our knowledge, may undermine "the refined mathematical edifice built thereon". Using the two catalogues mentioned, he considers the *sense* alone of their respective motions, whether reflecting "pro"-solar motion, or the reverse—"con". In this way he by-passes assumptions for distance (for cross-motions), etc., and also the general assignment of arbitrary limits for acceptable motions. A full explanation of the method appears in the paper, to which reference must be made for details of the method; Mr. Walkey states that the method is a development of that mentioned by Russell, Dugan and Stewart in "Astronomy", vol. 2. As a result of his investigation, involving 40,720 star motions, Walkey's conclusions are as follow: position of solar apex, 1900·0; R.A. 270·2° ± 0·3°, Dec. + 28·7 ± 0·5°. The solar velocity of approach was found to be 20·5 ± 0·6 km./sec., its galactic planar component being 19·0 km./sec. and the normal 7·75 km./sec.

## Metal Caps for Test-tubes

WE have received from Messrs. Oxo, Ltd. (Thames House, Queen St. Place, E.C.4), samples of metal caps for test-tubes. These caps have been used for some time in their laboratories, and Messrs. Oxo offer to supply them free of charge to other laboratories which ask for them. The caps are intended as a substitute for cotton wool plugs, and Messrs. Oxo claim for them the following advantages: test-tubes of media fitted with the caps remain sterile for long periods; there are no fibres to contaminate the media; tubes fitted with the caps can be sealed with 'Cellophane'; the caps can be labelled with an ordinary pencil and this labelling withstands autoclaving; they are easily removed and replaced and do not stick to the mouths of the tubes; the caps last a long time and can be cleaned by boiling in 0·5 per cent caustic soda, followed by rinsing and drying. The caps appear to be made of an aluminium alloy and are supplied in three sizes to fit standard test-tubes with outside diameters of $\frac{5}{8}$, $\frac{3}{4}$ and 1 in.

## Rare and Historic Maps

MR. FRANCIS EDWARDS, 83 Marylebone High Street, London, W.1, has issued a catalogue (No. 692) of maps and atlases of the British Isles from the sixteenth to the nineteenth centuries which contains several items of unusual interest. There is a first edition of Camden's "Britannia" with 57 double-page maps, and also a copy of Collins' "Coasting Pilot" of 1693 with 48 maps. Perhaps more noteworthy are several copies of different editions of Speed's atlas, including the rare fully-coloured one, and a first edition of Saxton's atlas of England and Wales. The catalogue also lists a copy of that rarest of all sea atlases, "Arcano del Mare" of Robert Dudley, Duke of Northumberland, with 133 maps, and plans and diagrams.

## Geology in Scotland: Swiney Lectures

THE first half of the course of Swiney Lectures on geology are being delivered (December 6–17) by Dr. Douglas A. Allan, director of the Royal Scottish Museum, at the Museum itself in Chambers Street, Edinburgh. The general title covering the twelve lectures is "The Geology and Scenery of Scotland". This is the first time that Swiney Lectures, which are under the direction of the British Museum (Natural History), have been given outside London, and Mr. N. B. Kinnear, director of the Museum, presided at the opening lecture. The last six lectures will be delivered at the same place at 5.30 p.m. on Mondays, Wednesdays and Fridays during January 17–28, 1949.

## Announcements

PROF. ERNST GAUMANN, of the Federal Technical College, Zurich, has been elected *correspondant* for the Section of Botany of the Paris Academy of Sciences, in succession to Dr. A. F. Blakeslee, who has been elected a foreign associate of the Academy.

PROF. E. G. CULLWICK, director of the Electrical Research Division, Research Defence Board, Ottawa, will be the first occupant of the new Watson-Watt chair of electrical engineering at University College, Dundee.

DR. J. L. B. COOPER, of the Department of Mathematics, Birkbeck College, University of London, has been appointed to the University readership in mathematics tenable at the College.

A SERIES of four sessions on the "Educational and Social Significance of the Land" has been arranged by the Association of Agriculture and the University of London Institute of Education, to be held at the latter's headquarters in Malet Street, London, W.C.1. The first session has already been held and the remaining three will be at 10 a.m. on December 11, and February 5 and 19. At each session two lectures of one hour's duration will be delivered, and emphasis will be laid on teaching methods in the middle forms of secondary schools. Admission is **1*s.*** per session or **2*s.* 6*d.*** for all four, and further details may be had on application to the general secretary, Association of Agriculture, Abbey House, Victoria Street, London, S.W.1.

A SERIES of three Christmas Lectures, especially adapted for a juvenile audience of from twelve to seventeen years of age, will be given in the Royal Photographic Society's House, at 16 Princes Gate, London, S.W.7, on December 29, 30 and 31, 1948. A special house exhibition, comprising Nature subjects, is being arranged by Mr. Oliver Pike to coincide with the lectures. The lecturers and subjects will be as follows: "The Chemistry of the Process", by Dr. H. Baines; "Formation of the Image and Making the Negative and Print", Part 1, by Mr. K. H. Gaseltine, and Part 2 the next day. Admission will be free but by ticket only, obtainable on application to the Secretary of the Society at the above address.

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications*

## Artificial Stimulation of Rain

DURING the past summer here, the South African Council for Scientific and Industrial Research, with the assistance of the Division of Meteorology and the South African Air Force, arranged a series of experiments to examine the practical possibilities of the artificial stimulation of precipitation.

As natural conditions in the Transvaal in summer are particularly favourable for the development of convective cloud, the experiments were directed mainly to an investigation of the effects produced by the release of 'dry ice' into developing cumulus cloud or incipient thunderstorms.

Experiments were carried out from January to April, 1948, on days on which fairly numerous thunderstorms were expected to occur, and selected clouds were 'seeded' with 'dry ice', development being observed by means of a 3-cm. radar, the aerial system of which consisted of a rotating parabolic reflector producing a 2°-beam, the elevation of which was manually adjustable. Display was by PPI, and arrangements provided for the aircraft position to be indicated directly on the screen. A photographic record of the screen on 16-mm. film was made automatically at predetermined intervals.

'Dry ice', crushed to ¼–¾ in. mesh, was dropped within, or 200–400 ft. above the tops of, thirty-six cumulus clouds on six days, and the following is a summary of the results of the photographic record of the radar display.

| | | |
|---|---|---|
| 1. | No echoes observed .. .. .. .. .. | 4 occasions |
| 2. | Echoes doubtful owing to permanent echoes and close-in clutter .. .. .. .. .. | 8 ,, |
| 3. | Echoes of less than 15 min. duration : | |
| | (*a*) First appearance in less than 30 min. .. | 4 ,, |
| | (*b*) ,, ,, between 30 and 90 min. .. | 4 ,, |
| | (*c*) ,, ,, after more than 90 min. .. | 2 ,, |
| 4. | Echoes of more than 15 min. duration : | |
| | (*a*) First appearance in less than 30 min. .. | 7 ,, |
| | (*b*) ,, ,, between 30 and 90 min. .. | 5 ,, |
| | (*c*) ,, ,, after more than 90 min. .. | 2 ,, |

'Dry ice' was dropped when air temperatures were between 7° F. and 29° F., and at a rate ranging from 20 lb. to 200 lb. per minute, into cumulus cloud which observation showed to consist of supercooled water droplets. Echoes from clouds seeded at the lower temperatures occurred more consistently than those from clouds seeded at temperatures nearer freezing; but from the limited number of experiments, no conclusions could be reached regarding the comparative effectiveness of the different quantities of 'dry ice' employed.

The experiments indicate that the use of 'dry ice' undoubtedly had the effect of inducing precipitation at an earlier stage in the life of the cloud than is normally the case. Such precipitation was often associated with lightning and, on one occasion at least, lightning was observed below a cloud fifteen minutes after it had been seeded, although its imminence was not suggested by the development and general appearance of the cloud.

The information at our disposal is not sufficient to draw any conclusions as to whether this stimulated precipitation affected the intensity of rainfall which would probably have occurred later from the seeded clouds, and whether it prolonged its duration or extended the area over which it fell.

Temperature observations made during these flights with a sensitive electrical thermometer show remarkably large temperature variations in horizontal flight. In one case a difference of 7° F. during a few miles of horizontal flight in clear air at about 20,000 ft. was noted. Temperatures recorded within cumulus clouds were frequently lower than those observed in clear air at the same pressure just outside the cloud.

We wish to thank the Director of the Division of Meteorology, the Director-General and officers of the South African Air Force, and Messrs. National Chemical Products for their generous co-operation and help in these experiments.

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## Condensation of Water Vapour Below 0° C.

AN apparatus has been constructed which permits ultra-microscopic observation of individual condensation nuclei in an expansion chamber. The chamber may be cooled by immersion in a low-temperature bath, and the air in it supersaturated on further cooling by sudden small expansions. The object has been to study cloud formation at temperatures below 0° C., particularly in order to discover under what conditions ice crystals appear and whether they are the result of direct sublimation from vapour to ice or of the condensation and subsequent freezing of water droplets. This question has considerable meteorological importance, since the presence of ice crystals in a cloud is often supposed to be essential to the development of rain.

*Outdoor air.* Experiments with outdoor air have shown that above — 32° C. condensation occurs almost entirely in the form of water droplets, and that ice nuclei, if present, do not exceed 1 per c.c. When the final temperature at the end of the expansion falls below a threshold, which appears to vary between — 32° C. and — 35° C., clouds are usually seen to contain ice crystals in numbers up to 20 per c.c., although water droplets remain far more numerous and may be about 1,000 per c.c. The number of ice crystals does not noticeably increase when final temperatures are lowered from — 35° C. to — 40° C., nor with increasing supersaturation. Between — 41° C. and — 42° C., however, a very sharp increase occurs, and below — 42° C. clouds are composed mainly, if not entirely, of ice crystals.

An important feature of all ice crystal formation in outdoor air is that it occurs only when the air, initially saturated with respect to ice, is cooled by expansion to the dew-point (to saturation with respect to water). This strongly suggests that the crystals are formed not by direct sublimation but by the condensation and immediate freezing of water droplets (no case has been observed of the freezing of a fully grown water droplet). It is therefore proposed that such ice nuclei should be known as 'freezing nuclei', and that the term 'sublimation

nuclei' should be reserved for any which permit sublimation from vapour to ice strictly at the frost-point.

The ice crystals formed in outdoor air do not, on evaporation, leave behind any sublimation nuclei. If the temperature of the chamber be raised gradually, clouds again appear mainly as water droplets as soon as final temperatures fail to reach − 41° C.

*Cleaned air.* Experiments were made in air from which the great majority of nuclei had been removed by filtration. Down to − 55° C. and with expansions of ratio up to 1 : 10 (the limits obtainable), condensation or freezing occurred only on the few nuclei remaining. Irradiation of the chamber with gamma rays from a radioactive source produced no effect. This is in contradiction to the observation of Cwilong[1].

*Contaminated air.* The threshold at − 41° C. has been observed not only in outdoor air but also in cleaned air contaminated with a wide variety of artificial nuclei, including those from sprayed sodium chloride and sodium nitrate solutions and from a red-hot platinum wire.

Certain nuclei, however, have been found to stimulate ice formation at higher temperatures. Silver iodide, the effect of which on supercooled water fogs has been reported by Vonnegut[2], provides, when volatilized, freezing nuclei active at temperatures as high as − 6° C.

Only one instance of true sublimation has yet been observed. This was on nuclei produced by a spray of cadmium iodide solution, but only after an ice cloud had been formed on them by expansion to a temperature below − 42° C. The ice crystals thus formed left behind, on evaporation, small particles which acted as true sublimation nuclei at temperatures up to − 10° C. Further warming to − 9° C. caused a 'melting' of these nuclei, which then reverted to giving only water droplets, even on subsequent cooling to − 25° C. It may be noted that the freezing point of a saturated solution of cadmium iodide, in bulk, is in the neighbourhood of − 9° C.

Both silver iodide and cadmium iodide occur in hexagonal crystals which have lattice constants within 7 per cent of those of ice-I.

*Nuclei from rain-water.* Some recent experiments on the nuclei produced by a spray of rain-water collected during a thunderstorm have revealed the presence of small numbers of nuclei which gave ice crystals at temperatures as high as − 20° C., but which were evidently not common enough to be detected by normal experiments on outdoor air. These may be the nuclei discovered by Findeisen[3], though it was clear that they acted as freezing, and not sublimation, nuclei.

My thanks are due to Lord Cherwell for enabling me to work at the Clarendon Laboratory; and to the Department of Scientific and Industrial Research for a maintenance grant. It is a pleasure to acknowledge my debt to Prof. G. M. B. Dobson for his continued interest and valued advice on many occasions.

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Clarendon Laboratory,
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June 30.

[1] Cwilong, B. M., *Proc. Roy. Soc.*, A, **190**, 137 (1947).
[2] Vonnegut, B., *J. App. Phys.*, **18**, 593 (1947).
[3] Findeisen, W. and Schulz, G., "Forschungs und Ehrfahrungsberichte des Reichwetterdienstes", A, No. 27 (1944).

## A Concentration of Uranium in Black Muds

In the Cambrian black shales of the Oslo area, there is a considerable concentration of uranium, analyses values ranging from 25 to 180 gm./ton. (These and the following uranium analyses were made at the Norwegian Defence Research Institution, which has given permission for their publication.)

An interesting problem is how far a concentration is going on in the present-day black muds formed under anaerobic conditions. There is a large number of land-locked waters around the Norwegian coast, in which these black muds are deposited[1].

During the summer of 1947, I re-investigated these fjords, and the uranium content of some mud samples was determined. All analyses are made by the ether-extraction method and are thus independent of the radium content. In such recent sediments uranium and radium are not in an equilibrium.

The localities have already been described[1], and are here arranged according to the quantities of uranium found. The depth is also stated, as well as the content of hydrogen sulphide and oxygen in the deep waters.

| Locality | Depth from which sample is collected (m.) | Content of uranium (gm./ton) | Maximum hydrogen sulphide or minimum oxygen in deep waters (cm.³/l.) |
|---|---|---|---|
| Topdalsfjord | 65 | 60 | *c.* 1 $H_2S$ |
| Søndeledpoll | 18 | 50 | 5·4 |
| Isefjærfjord | 26 | 50 | 7·9 |
| Hellefjord | 70 | 40 | 40·7 |
| Framvaren I | 160 | 40 | 199·5 |
| Framvaren II | 160 | 35 | 199·5 |
| Vestrhusfjord | 53 | 35 | 9·9 |
| Mortensfjord | 34 | 20 | 1·6 |
| Drammensfjord | 117 | 15 | 4·8 |
| Oksefjord | 81 | 13 | 3·2 $O_2$ |

There seems to be a definite connexion between drainage from granite areas and uranium content in the black muds, this being most conspicuous with the record value of 60 gm./ton in Topdalsfjord, into which empties a large river draining extended granite areas.

The precipitation probably starts by the formation of sulphide on the interface between the upper ventilated brackish waters and the salt waters of the deep, containing hydrogen sulphide.

By comparing my old core samples with echo soundings taken during the summer of 1948, I was able to ascertain the thickness of the layers of blackish muds to range from less than a metre up to some 20 metres in a few isolated places.

Two of the three fjords which stand apart by their low values are, as a rule, quite well ventilated, while in the Drammensfjord the muds are not very black and there is probably a considerable redeposition of clay from the shores. Even here there is some concentration in relation to the granitic batholith in which the Drammensfjord is situated; but from which it receives only a very small part of its freshwater supply, and in which the uranium content is some 10 gm./ton.

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## Range-Energy and Other Relations for Electrons in Kodak Nuclear Plates

KODAK Nuclear Track plates of type *NTP* 2, 30 $\mu$ in thickness, have been exposed in a low-resolution β-ray spectrograph using uniform magnetic fields of 279 and 302 oersteds. The focused line had a half-breadth of about 1 mm. The rays entered the plate at a grazing angle, the central ray meeting the plate at 6°. 'Line' sources of thorium (B + C) and radium E were used to provide continuous spectra. Exposure times were such as to give, in the 80-keV. energy region, about $2 \times 10^3$ β-rays per sq. cm. on a surface normal to the central ray. The plates were developed for 20 min. at 18° C. in 'Kodinol' developer.

Emulsions of two different sensitivities were used, the normal *NTP* 2*a*, and an experimental emulsion having larger grains and higher sensitivity than the *NTP* 2*a*. The chemical constitution of the two emulsions was the same. In the *NTP* 2*a* plates, electron tracks could be followed easily up to 50 keV., and with some difficulty up to 80 keV. energy. In the more sensitive emulsion, the upper energy limit for the range measurements was set by the thickness of the emulsion. The longest observed track was of 94·4 $\mu$ with corresponding energy almost certainly greater than 150 keV. (see below). Fig. 1, from a radium E plate, shows a 'background' track (probably of a secondary electron due to high-energy *Bremsstrahlung*). This track is 81·4 $\mu$ long and contains about 65 grains. Fig. 2 shows an 80-keV. track from radium E (27·8 $\mu$ and 32 grains).

Measurements were made of the ranges of unbranched tracks (a branch could not be identified with certainty if its energy were below about 20 keV.) starting in the surface of the emulsion and having an initial direction within 40° of the central ray direction. Working from grain to grain, observations were made of projected lengths and differences of depths. Depth measurements were corrected for shrinkage of the emulsion in processing. The range data from the higher sensitivity plates are given in Table 1. Because of the limited thickness of the emulsion, the 100-keV. range may be somewhat low, and is therefore enclosed in brackets.

Table 1

| No. of tracks observed | Mean energy of tracks (keV.) | Mean range of tracks ($\mu$)* | Standard deviation of ranges | Mean No. of grains per track* | Standard deviation of number of grains |
|---|---|---|---|---|---|
| 25 | 30 | 6·90±0·33 | 1·67 | 10·8±0·4 | 2·0 |
| 25 | 40 | 11·00±0·57 | 2·84 | 14·4±0·4 | 2·0 |
| 25 | 50 | 15·78±0·50 | 2·51 | 20·4±0·7 | 3·6 |
| 25 | 60 | 22·15±1·12 | 5·62 | 22·4±1·0 | 4·9 |
| 25 | 80 | 32·65±1·55 | 7·74 | 35·5±1·4 | 6·9 |
| 25 | 100 | (42·09±1·99) | 9·94 | 41·0±1·6 | 7·9 |

* With standard error.

The grain density along the 100-keV. tracks was analysed in 5 $\mu$ portions of the tracks, working backwards from the last grain of the track. The results are given in Table 2.

Table 2

| Portion of track from the last grain | Mean number of grains per 5 $\mu$* | Standard deviation of number of grains |
|---|---|---|
| 0–5 $\mu$ | 7·0±0·3 | 1·7 |
| 5–10 | 5·3±0·3 | 1·3 |
| 10–15 | 5·2±0·3 | 2·5 |
| 15–20 | 4·6±0·3 | 1·3 |
| 20–25 | 4·3±0·2 | 1·0 |
| 25–30 | 4·3±0·3 | 1·3 |
| 30–35 | 4·1±0·3 | 1·1 |
| 35–40 | 3·7±0·3 | 1·0 |

* With standard error.

The relative stopping power of the emulsion may be defined as $\Delta R_a/\Delta R$, where $\Delta R_a$ is change of range in air at 760 mm. mercury pressure and 15° C., and $\Delta R$ is change of range in emulsion for the same change of energy of the β-particles from $V_A$ to $V_B$. Thus defined, the relative stopping power is a function of the mean energy $V = \frac{1}{2}(V_A + V_B)$. Values of relative stopping power given in Table 3 were deduced from the data in Table 1 and from calculated mean ranges of electrons in air given by Tsien, Marty and Dreyfus[1], and shown by Tsien[2] to be in close agreement with experimental values in the region of energy up to 50 keV. If the 100-keV. range in Table 1 is low, the 90-keV. stopping power in Table 3 will be high.

Table 3

| $V$ in keV. | Relative stopping power of emulsions, with standard error |
|---|---|
| 35 | 2640± 420 |
| 45 | 2720± 430 |
| 55 | 2290± 440 |
| 70 | 3130± 570 |
| 90 | (3840±1030) |

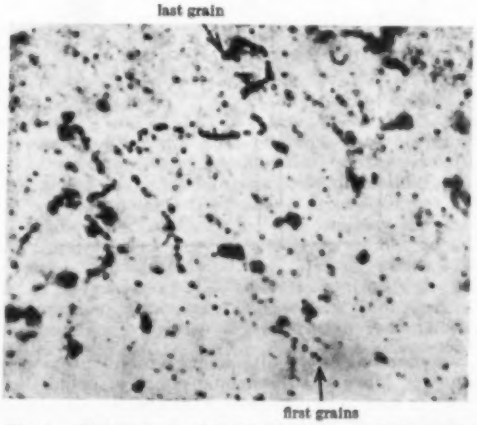


Fig. 1. Electron track of length 81·4 $\mu$; magnification 1,260

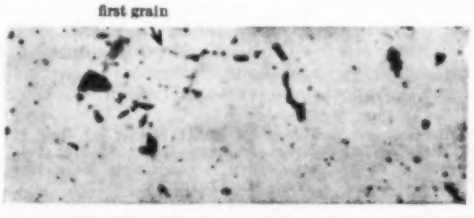


Fig. 2. Electron track of 80-keV. energy; magnification 1,260

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Edinburgh. Oct. 23.

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## The Superconductive Transition

In 1931 de Haas and Voogd[1] showed conclusively that the electrical resistance of a single crystal of very pure tin vanishes discontinuously at the transition temperature. In this experiment the external magnetic field was zero, and the transition curve was extrapolated to zero measuring current. They showed also that physical or chemical impurity produces an extended transition region. Since then it has been generally assumed[2] that such an abrupt change of resistance also takes place when the transition occurs in a (longitudinal) magnetic field, extended transitions being ascribed to impurities. Experiments carried out in this Laboratory[3,4] on very pure lead exhibiting transitions extending over a wide range of magnetic field cast doubt, however, on the validity of this assumption.

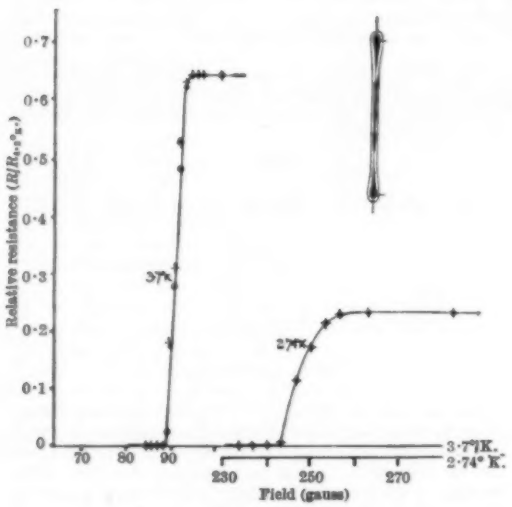


Fig. 1. ⊙ Ascending; + descending

The true shape of the transition curve is clearly of fundamental significance when analysing the mechanism of the disappearance of the electrical resistance, and we have therefore investigated this problem more carefully. Specimens of very pure tin, lead and mercury which had been prepared *in vacuo* were examined in a longitudinal magnetic field. Preliminary experiments showed that the way in which the leads were attached strongly affected the transition, and finally a method was adopted (to be described in detail elsewhere) by which the potential leads were attached free of strain, without solder and without causing distortion of the magnetic field over the length of the specimen. Under these conditions, in all three metals, the transition curves were of a similar general shape (see Fig. 1). The width of the transition region increases rapidly with the *absolute* value of the critical field ($H_c$), which means that for a given value of $H_c/T$ a transition in lead is more extended than in tin. Incidentally, this behaviour makes it clear that the transition broadening cannot be simulated by inhomogeneities in the external field. The ultimate criterion for the purity of our specimens was, in the case of tin, provided by comparison of the transition in zero field with those observed by de Haas and Voogd[1]; this showed that our specimen corresponded to their purest single crystal.

It was remarkable, in view of the purity of our specimens, that in no case did we observe hysteresis, a phenomenon commonly ascribed to the transition of pure single crystals. It had been suggested by one of us[5] that resistance hysteresis[6] may be due to the geometrical shape of the ends of the wires, and we therefore investigated a mercury specimen which ended in bulbs carrying the contacts. In every other respect its preparation was identical with the specimen of Fig. 1, thus ensuring similar purity and crystalline state. The result, illustrated in Fig. 2, shows quite marked hysteresis with *discontinuous* jumps, thereby demonstrating that these features are produced, in fact, by the overall geometry of the specimen. A full explanation of this curious behaviour cannot be provided at this juncture. A most puzzling feature is that on occasion the whole transition from zero to normal resistance, when hysteresis is present, can cover a narrower range of magnetic field than the reversible transition of the straight specimen.

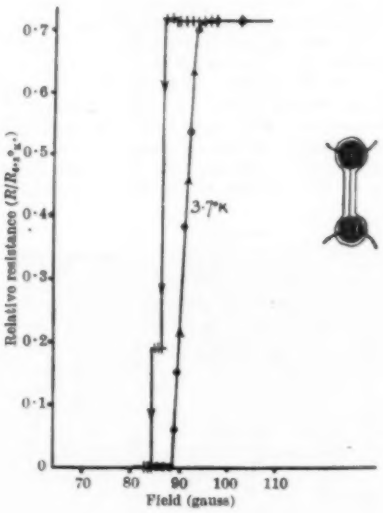


Fig. 2

Summarizing our results, we have found no evidence whatever (once the disturbing effect of geometrical shape is removed) that either discontinuous change of resistance or hysteresis are to be regarded as characteristic attributes of the superconductive transition in a magnetic field.

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Oct. 22.

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[2] Shoenberg, D., "Superconductivity" (Camb. Univ. Press, 1938).
[3] Pontius, R. B., *Phil. Mag.*, **24**, 787 (1937).
[4] Daunt, J. G., *Phil. Mag.*, **28**, 24 (1939).
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[6] de Haas, W. H., *Leipziger Vortraege* (1934).

## Measurement of Alkaline Earth Ion Concentrations by Rennet Action

THE relatively high temperature coefficient of the second or cationic precipitation stage of rennet action on casein allows its separation from the first or enzymic stage to be made by appropriate choice of temperatures[1]. Thus the first stage can be completed at 0–5° C., and the second afterwards initiated at about 35° C. The coagulation time at the higher temperature, extremely sensitive to variations in alkaline earth ion concentration within a fairly narrow range, can then serve as a measure of such concentrations.

Measurements are made on solutions of the appropriate caseinate, relatively small volumes of which have been brought, by dialysis at 0–5° C., into equilibrium with the solutions to be tested and a suitable range of standards. Solutions tested and standards for comparison should both agree approximately in content of ions of other valencies, the presence of which, particularly of polyvalent anions, influences the alkaline earth ion concentration for coagulation.

Determinations made by this method of the dissociation constants of calcium and barium citrates, $K = [Me^{++}] \times [Citr.'''] / [Me\ Citr.']$, at 2° C. and an ionic strength $\mu$ 0·03 give the values $0{\cdot}35 \times 10^{-3}$ and $1{\cdot}2 \times 10^{-3}$ respectively, in fair agreement with those obtained by other methods[2,3].

A fuller account of this work with further applications will appear elsewhere.

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[3] Joseph, N. R., *J. Biol. Chem.*, **164**, 529 (1946).

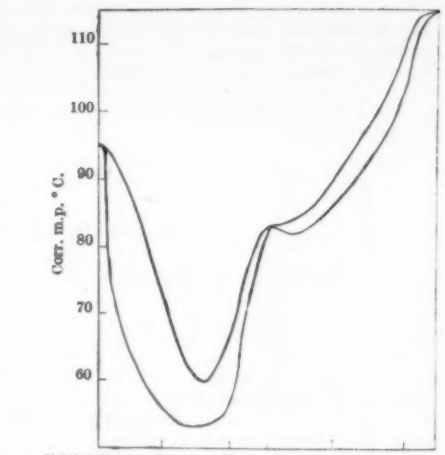
## Purity of Diphenylene Oxide (Dibenzofuran)

WE wish to direct attention to the anomalous melting points (82–87° C.) quoted in the literature[1–7] for diphenylene oxide. It is likely that these anomalies are due in part to the mode of formation, and we have examined the particular cases of the isolation of diphenylene oxide (*a*) from coal tar distillates, and (*b*) by the distillation of phenol over litharge[8].

In the latter case, we isolated diphenylene oxide (styphnate, m.p. 139° C.), corresponding to the classical formula $C_{12}H_8O$, of melting point 82·8–83° C. (corr.)—not 87° C. as found by Gallewsky and afterwards by Cullinane. The melting point remained unchanged by further crystallization from alcohol and/or acetic acid, and ultimate analysis gave carbon 85·3 per cent, hydrogen 5·0 per cent.

The isolation of diphenylene oxide from coal tar is closely attended by the lower boiling acenaphthene ($C_{12}H_{10}$, melting point 95° C., boiling point 278° C.) and the higher boiling fluorene ($C_{13}H_{10}$, melting point 114–115° C., boiling point 293° C.). The accompanying graph illustrates equilibrium diagrams, based on pure components, which we have constructed using the thaw-melt method for the systems acenaphthene–diphenylene oxide, diphenylene oxide–fluorene.

It will be noted that diphenylene oxide isolated from coal tar and possessing a melting point lower than 82° C. is probably contaminated with acenaphthene, a higher melting point indicating probable contamination with fluorene.




(1) Acenaphthene; (2) diphenylene oxide; (3) fluorene

It is where fluorene is the contaminant that caution is needed in describing the purity of diphenylene oxide, for up to 20 per cent contamination changes the melting point but little from 82·8° C. From the graph, coal tar diphenylene oxide with a melting point of 86° C. would contain about 35 per cent fluorene: this is roughly substantiated by our ultimate analysis of such a sample (carbon, 88·0 per cent; hydrogen, 5·2 per cent), which can be calculated to correspond with a mixture of 7 parts of diphenylene oxide and 3 parts of fluorene.

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London, S.W.11. June 23.

[1] Hoffmeister, *Ann.*, **159**, 211 (m.p. 80–81° C.).
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[3] Graebe and Ullmann, *Ber.*, **29**, 1876 (1896) (80–81° C.).
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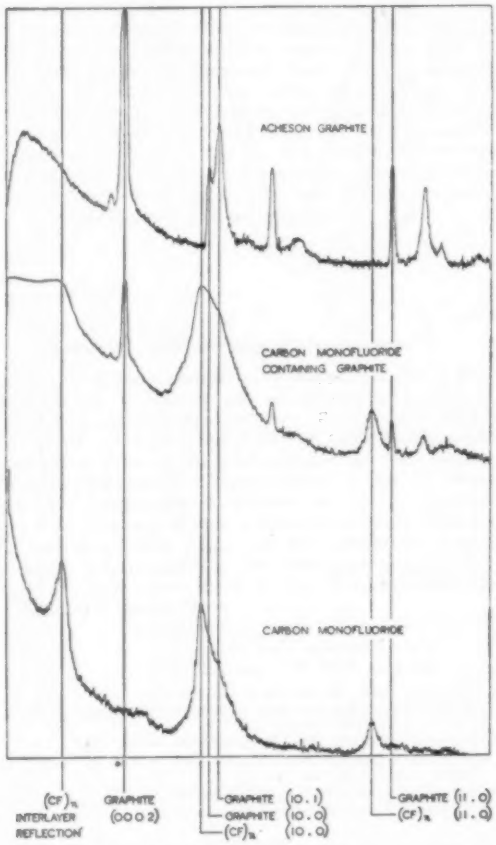
[5] Kruber, D.R.P., 491, 594 (84° C.).
[6] Hale and Stoesser, U.S.P. 1,808,349 (82–83° C.).
[7] "International Critical Tables", **1**, 244 (87° C.).

## Structure of Carbon Monofluoride

Ruff and Bretschneider[1], in collaboration with Ebert, reported that the X-ray diffraction pattern of carbon monofluoride, $(CF)_n$, had similar (*hk*.0) reflexions to graphite, but that the (00*l*) and other reflexions dependent on the *c* or carbon interlayer spacing were absent. From this they assumed that in carbon monofluoride the graphite structure is retained with expansion perpendicular to the carbon layers and, from a determined density of 2·39, calculated the carbon interlayer spacing to be 8·17 A. They postulated that the fluorine atoms acquire electrons from the carbon rings and that the ions so produced lie in a closely packed structure in six parallel layers between each pair of carbon planes requiring a theoretical carbon interplanar spacing of 8·05 A. Although such a structure could reasonably account for the low electrical conductivity and explosive decomposition of the compound, it is very doubtful, as pointed out by Bigelow[2], whether such an arrangement would have even limited stability. Bigelow proposed an alternative structure in which

the fluorine atoms lie in two parallel planes about each plane of carbon atoms, to which they are linked by polarized covalent bonds. Assuming a normal C—F bond of about 1·4 A., the excessively high spacing of 5·3 A. between the planes of fluorine atoms was explained by electrostatic repulsion resulting from the polarization.




Carbon monofluoride has recently been prepared in this laboratory by the action of fluorine on Acheson graphite at temperatures between 420° and 450° C. The product is grey-fawn in colour, has an analysis of 37·2 per cent C, 61·2 per cent F (theoretical for CF : 38·7 per cent C, 61·3 per cent F) and a maximum density determined by immersion of 2·78 gm. per ml. : this density is considerably greater than that reported by Ruff and Bretschneider. X-ray diffraction photographs of this material are also rather different from those described by Ruff and Bretschneider. Photometric plots of the carbon monofluoride pattern, together with plots of the original Acheson graphite and a sample containing some free graphite for comparison, are shown in the accompanying figure. Carbon monofluoride shows fairly intense low-angle scattering terminated by a broad line (not reported by Ruff and Bretschneider) corresponding to an interplanar spacing of about 6·0 A. In addition, it is seen that the other two strong reflexions with interplanar spacings of 2·23 and 1·30 A. do not coincide with the (10.0) and (11.0) reflexions of graphite, which have spacings of 2·14 and 1·24 A. respectively. The ratio of these two spacings for carbon monofluoride is 1·716 against the theoretical 1·732, that is, $\sqrt{3}$, for $d_{(10.0)}/d_{(11.0)}$ in a hexagonal lattice. It therefore seems probable that the carbon atoms in carbon monofluoride are arranged similarly to those of graphite, with an expansion of the C—C distance and a slight distortion from the true hexagonal arrangement. This hypothesis is supported by the observation of two very weak reflexions with spacings 1·11 and 0·84 A. which can be indexed as (20.0) and (12.0) respectively. The calculated average C—C spacing is 1·49 A., compared with the value of 1·42–1·43 A. for graphite.

With the expanded hexagonal lattice, the corresponding *c* or carbon interlayer spacing calculated from the determined density of 2·78 is 6·3 A. ; and it is reasonable to assume that the measured spacing of 6·0 A. corresponds to this dimension in the carbon monofluoride structure, since the above density is likely to be a minimum. The increase of the C—C distance to 1·49 A. suggests the loss of part of the double-bond character of this link, and supports Bigelow's suggestion of the formation of a polarized C—F covalent link. Taking the C—F distance in this bond as about 1·5 A., as against the normal value of 1·43 A., the distance between the fluorine planes would be 3·0 A., which is a reasonable polarized van der Waals' separation. The marked change in the intensity ratio of the (10.0) : (11.0) reflexions from 8 : 10 in graphite to 10 : 1 in carbon monofluoride, and the observation of the (20.0) and (12.0) reflexions, support the probability of a fairly rigid C—F bond in carbon monofluoride ; although the actual positions of the fluorine atoms cannot be deduced with any certainty. The absence of general (*hk.l*) reflexions may be caused by a turbostratic arrangement[3] of the carbon/fluorine layer-plane units. This may also account for the falling off at higher reflexion angles, usually associated with cross-lattice reflexions[4], of the (10.0) reflexion ; but this is difficult to reconcile with the symmetrical (11.0) reflexion, unless the matter is further complicated by the slight distortion from the true hexagonal lattice.

Calculation of crystallite size from the line broadening shown in the diffraction patterns gives 20–40 A. in a direction perpendicular to the carbon layers and about 50–80 A. in the layers for carbon monofluoride, compared with an approximate 200 A. for the original graphite. This marked decrease in crystallite size is consistent with the reduced van der Waals' forces and the partial utilization of the π-electrons of the graphite structure in the formation of C—F bonds.

*Note added in proof.* We have since seen a review of the work by Rüdorff and Rüdorff[5], but not their original papers. Our experimental results are essentially similar to theirs, but it is difficult to reconcile their proposed 'hydroaromatic giant molecule' structure with the marked change in reflexion-intensity ratio reported by us.

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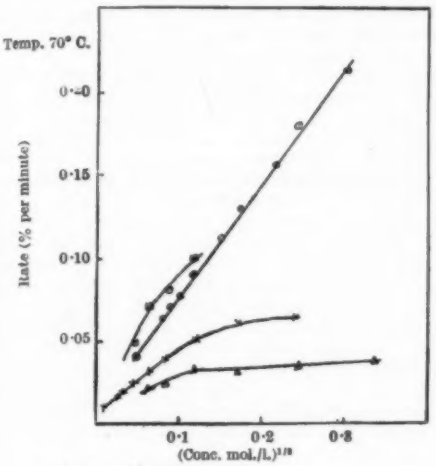
## Peroxide Catalysed Vinyl Polymerization

In recent months the importance of the reactivity of the free radicals in polymerization systems has been stressed, in particular the ability of a free radical both to initiate and terminate reaction chains[1]. The emphasis, however, has been on the ability of the radical in question to terminate the growing chains[2], and it is the object of the present communication to direct attention to the lowered rate of initiation of growing chains which results from the use of certain catalysts.




○—○—, Benzoyl peroxide.
△—△—, Di-*m*-nitrobenzoyl peroxide.
×—×—, *m*-Nitrobenzoyl benzoyl peroxide.
□—□—, Di-2,3,4,5-tetrachlorobenzoyl peroxide.

A feature of peroxide catalysed vinyl polymerizations is that the rate of reaction is proportional to the square root of the catalyst concentration. This, however, is true only for catalysts which generate active free radicals, when the catalyst is used over a wide range of concentrations. The results given in the accompanying graph show that in the polymerization of styrene using di-*m*-nitrobenzoyl peroxide, *m*-nitrobenzoyl benzoyl peroxide and di(2,3,4,5-tetrachlorobenzoyl) peroxide this relationship does not hold. Initial rates of reaction were determined, as the rate fell off fairly rapidly with time in the case of these poor catalysts. Benzoyl peroxide gives a good linear agreement. The observed deviation from linearity occurs with catalysts which give radicals of low activity. (It will be shown again that the activity of a radical is related to the distribution of electron density; thus electron repelling substituents increase the reactivity of a radical, and electron attracting substituents lower the reactivity. Mesomeric effects either supplement or reverse the inductive effect, depending on the direction of electron transfer.)

When incorporated in the kinetic scheme:

$$
\begin{array}{lcll}
 & C & -k_i \rightarrow & R. \\
R. + & M & -k_p' \rightarrow & P_1. \\
P_1. + & M & -k_p \rightarrow & P_2. \\
P_r. + & M & -k_p \rightarrow & P_{r+1}. \\
P_r. + & P_s. & -k_{t_1} \rightarrow & M_{r+s} \\
P_r. + & R. & -k_{t_2} \rightarrow & M_r \\
R. + & R. & -k_{t_3} \rightarrow & R_2
\end{array}
$$

application of the stationary state method of analysis used by Melville and others[3] gives, when the three termination coefficients are considered to be equal ($k_t$) (the terms having their customary significance):

$$\Sigma (P_r.) = \frac{k_p'(M)(R.)}{\sqrt{k_i k_t (c)}},$$

$$(R.) = \frac{k_i(c)}{\{k_p' (M) + \sqrt{k_i k_t (c)}\}}.$$

Thus the reaction-rate:

$$
\begin{aligned}
-\frac{dM}{dt} &= k_p' (M)(R.) + k_p (M)\Sigma(P_r.) \\
&= k_p' (M) \sqrt{\frac{k_i(c)}{k_t}} \left\{ \frac{k_p (M) + \sqrt{k_i k_t(c)}}{k_p' (M) + \sqrt{k_i k_t(c)}} \right\}
\end{aligned}
$$

This reduces to the usual form for zero-order initiation when $k_p' = k_p$. This expression gives a linear relationship between the reaction-rate and the square root of the catalyst concentration only when the concentrations used are very small or when $k_p'$ and $k_p$ are nearly equal. To suggest, as has been done, that the three termination constants are equal is a great over-simplification since, for definite values of $k_p$ and $k_t$, at low concentrations of catalyst the rate would be dependent upon $\sqrt{k_i(c)}$, which is probably not true. However, preliminary results from the intrinsic viscosities of the polymers indicate that these fall normally with increase in catalyst concentration, as would be predicted from the above scheme.

Also:

$$
\begin{aligned}
\overline{P_n} &= \frac{V\ (\text{prop.})}{V\ (\text{init.})} = \frac{(M)\{k_p' (R.) + k_p \Sigma(P_r.)\}}{k_p' (M)(R)} \\
&= \frac{k_p (M)}{\sqrt{k_i k_t (c)}}.
\end{aligned}
$$

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## Red Lead as a Selective Oxidant

Since the fundamental investigations of Dimroth[1], Criegee[2], Malaprade[3] and Fleury[4], lead tetra-acetate and periodic acid as selective oxidants have played an important part in organic chemistry, particularly for the elucidation of the structure of carbohydrates and related compounds and also from the preparative point of view[5]. It has been found now that red lead ($Pb_3O_4$) in many cases can be used successfully instead of the above-mentioned oxidants either in aqueous acetic acid medium or in organic solvents containing anhydrous acetic acid. It may be supposed that, in the presence of acetic acid, red lead gives rise with a limited velocity to intermediate formation of lead tetra-acetate which, in the presence of a suitable hydrogen donor, will be promptly reduced to lead diacetate. Therefore, the reaction mixture never contains an excess of tetra-acetate. Hence

red lead can be more generally used for the oxidation of aqueous solutions than lead tetra-acetate itself, as this rapidly hydrolyses in aqueous medium into uneffective lead dioxide.

For example, as preliminary experiments show, if an aqueous solution of 1 mol. of 1 : 2-propylene glycol is shaken or stirred with a mixture of 1 mol. of red lead and 8 mol. of acetic acid (initial acetic acid concentration 20–25 per cent) at room temperature, the red lead completely disappears within two to three hours and the propylene glycol yields, without formation of lead dioxide, 1 mol. of formaldehyde and 1 mol. of acetaldehyde respectively. One mol. of mandelic acid reacts with 1 mol. of red lead, yielding quantitatively benzaldehyde and carbon dioxide. 1 : 3, 2 : 4-Diethylidene sorbitol yields an aqueous solution of formaldehyde and 2 : 4, 3 : 6-diethylidene *l*-xylose, from which after acid hydrolysis crystalline *l*-xylose was obtained. Under the same conditions glycerol, sorbitol, mannitol, tartaric acid, lactose and sucrose were also smoothly oxidized without formation of lead dioxide. The oxidation of 1 : 2-propylene glycol and mandelic acid, respectively, by red lead in a chloroform solution in the presence of anhydrous acetic acid gave the same result as was obtained in aqueous medium.

On the other hand, ethylene glycol, α-methyl glucoside, diamino-ethane and alanine were not oxidized in appreciable amount in aqueous acetic acid medium. In these cases the red lead changed almost quantitatively within one to two hours into lead dioxide and lead diacetate.

Further studies on the selective oxidative effect of red lead are in progress; the results will be published later elsewhere.

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## Phosphorylase in Plastids

In a previous paper[1], a method has been described for the detection of the enzyme phosphorylase in plant tissues. Briefly, it consists of incubating free-hand sections of the tissue, previously freed of starch by starvation, in a buffered solution of glucose-1-phosphate, and subsequent staining in iodine–potassium iodide for the resultant starch. With this method a survey has been made of the distribution of phosphorylase in the tissues of many higher[1,2] and lower[3] plants. An interesting outcome of these observations is the finding that the enzyme is localized solely in the plastids. The evidence may be summarized as follows.

In the leaves of higher plants (*Verbena*, tobacco, squash, potato, corn, soybean, broad bean, castor bean) the enzyme activity is chiefly confined to the mesophyll and the guard cells. In these cells the activity is further limited to the chloroplasts. No reaction is ever found in the nucleus or the general cytoplasm. Each chloroplast may contain one or several loci of activity, which after prolonged incubation fuse to form a large starch grain. Thus the localization of the enzyme corresponds well with the site of normal starch synthesis as observed by Strasburger[4] and Zirkle[5].

Similarly, in the green algæ (*Spirogyra*, *Zygnema*, *Cosmaria*) phosphorylase activity is localized in the chloroplasts. It bears no observable relation with the pyrenoids, and is more or less evenly distributed in the plastids. Longer incubation often results in plasmolysis and appearance of fine starch granules outside the protoplast due, perhaps, to injury and leakage.

In plant parts which contain plastids coloured other than green, for example, the petals of nasturtium and the fruit of tomato, the enzyme is again only found in the chromoplasts.

Meristematic cells and cells not fully differentiated generally contain colourless plastids which may turn green later on. It is in these leucoplasts that phosphorylase activity resides, as proved in the embryos and seedlings of soybean, broad bean, potato, corn, etc. Each leucoplast may contain several centres of activity. Long incubation results in filling up the whole cells with starch, and some evidence of plasmolysis. In some cases (soybean) minute starch-like particles can be seen in the cytoplasm. They may have come from broken plastids or are masked original reserve[2], since they also appear in boiled sections and without incubation with glucose-1-phosphate. Sections of these tissues have also been made with the paraffin method and stained to bring out the cytoplasmic components. Again the enzyme activity is traceable to the leucoplasts, and no relation can be established with mitochondria or other cytoplasmic constituents[2].

In plants without visible plastids, for example, the blue-green alga *Oscillatoria* and the fungus *Rhizopus*, phosphorylase activity is found dispersed in the cytoplasm and gives rise to finely divided granules of starch or glycogen[3]. Long incubation results in whole sections of cells stained with iodine. Whether these loci of activity bear any relation to specific cytoplasmic entities remains to be investigated.

The only exception to the phosphorylase-plastid coincidence so far is found in the case of the red algæ. In *Batrachospermum*, reddish-brown staining polysaccharide formed from glucose-1-phosphate appears not in the chromatophores but scattered in the general cytoplasm[3]. It is interesting to note here that, in normal growth, the reserve polysaccharide of these algæ has long been known to be separate from the chromatophores[4]. Hypotheses have been advanced as to the origin of these particles of 'Floridean starch'. They are supposed either to have originated in the cytoplasm itself or grown out of the plastids. Our result supports the first contention, since the responsible enzyme phosphorylase is shown to be outside the plastids.

It may be added here that phosphorylase activity is not normally detectable in plant parts which form no starch. Examples are found in the shoot of onion and the petals of a number of flowers. Plants normally poor in the polysaccharide, for example, castor bean, are also low in phosphorylase activity[1]. In germinating seeds the number of starch grains finally formed in a cell is always smaller than the detectable loci of phosphorylase activity[2].

Summing up, we may say that phosphorylase in plants is localized in the plastids. No activity has been found in the nucleus and, except in the blue-green and red algæ and in fungi, in the cytoplasm.

The result lends support to the statement of Schimper and of Meyer[4] that starch is always formed in the plastids. It confirms also the anticipation of Hanes[5] that starch formation in the plastid (for that matter also outside the plastid, cf. *Batrachospermum*) is due to the phosphorylase mechanism.

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## Vestibular Effect of Streptomycin in the Mouse

UP to the present, experimental methods have yielded very little information concerning vestibular toxicity due to streptomycin; in medical practice these accidents are very frequent (80–90 per cent of cases treated). Indeed, the fundamental work of Molitor and his collaborators leads to the conclusion that most of the animals used in laboratory work show no recognizable vestibular disturbance, whether as the result of a single heavy dose of streptomycin or of several fractional doses administered over a period of time. According to Molitor[1], dogs are the only animals which show any evidence of cerebellar or vestibular damage comparable to that which has been observed in human beings, whereas mice, frogs, rats and guinea pigs are unaffected. Although Molitor kept under observation a considerable number of animals, we believe that his conclusions should not be accepted as final.

Our researches involved: (1) developing procedures which would enable us to study the vestibular function in the mouse; (2) the development of a suitable technique of labyrinthectomy for these animals, and a study of the phenomena which follow upon this operation, whether unilateral or bilateral; (3) the study of the reactions of a mouse upon receiving a single heavy dose of streptomycin or fractional doses over a period of time. By proceeding on these lines, we have been able to demonstrate a vestibular toxicity of streptomycin in the mouse, moderate in the case of acute intoxication, clear in the case of chronic intoxication[2]. When a heavy dose is administered, the response to the rotation test is in the nature of hyper-excitability. In chronic intoxication (30 mgm. in two daily doses), after about a week, a syndrome appeared which was progressively accentuated, and reproduced, in a lesser and variable degree, the effects of destruction of the labyrinth on both sides, namely, agitation, violent movements of the head in a vertical plane, absence of reaction to rotation, circling or waltzing, total loss of equilibrium and inevitable drowning in the swimming test.

In the mouse, then, the vestibular apparatus is remarkably sensitive to the action of streptomycin, a circumstance highly favourable for the study of this action, which at present is still very obscure.

Streptomycin is one of the two substances which are known to have specific toxic properties on the vestibular apparatus, the other being arsacetin, as Ehrlich[4] discovered when he described the 'artificial' dancing mouse. There appear to be no other compounds which, in the same conditions, display such a property.

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## Permeability of Muscle Cells

SINCE the advent of artificial radioactive elements, a considerable amount of work on the exchange of labelled ions or molecules against unlabelled ones of the same chemical nature has been carried out on biological material. Krogh has reviewed[1] a number of applications of the technique to exchanges between living cells and their surroundings, and Ussing[2] reports results obtained for the exchange of sodium between isolated muscle and Ringer solution. The remarks made by A. V. Hill[3] concerning measurements of so-called permeability of tissues appear to have been overlooked. He emphasized that diffusion might play the most important part in determining the rate of transfer of dissolved substances from lymph to tissue, even when the size of the tissue is only that of, say, a frog sartorius muscle. It appears, therefore, necessary when attempting to study cell-wall permeability either to use single cells, or to make allowance for the effect of diffusion being the means by which the extra-cellular fluid comes into eventual equilibrium with the fluid surrounding the assembly of cells. Experiments made *in vivo* will be less affected by the retarding influence of diffusion than will those made *in vitro*. This is because in the former case the blood-flow through the capillaries brings the substance being investigated into the interior of the tissue.

We have been making measurements of the rates of exchange of sodium and potassium between isolated frog sartorii and the surrounding medium. Equations describing the time-course of the combined permeation-diffusion process have been obtained. These allow the calculation of the apparent diffusion constant of sodium in the extra-cellular space of the muscle, and of the permeability to sodium and potassium. The apparent diffusion constant for sodium is $2{\cdot}0 \times 10^{-6}$ cm.$^2$/sec., which is a third of the value in free solution; this would correspond to the ion having to traverse a path $\sqrt{3}$ times the measured distance between outside and centre, which is not far from that expected if it has to pass round a series of cylinders. The permeability constant has to be defined, as there is no generally accepted formulation. For a cell in which the total concentration of the ion in question is static (that is, irrespective of whether the ions are labelled or not), the amount of ion entering per unit time equals the amount being lost, and we can write

$$P_o M_o = P_i M_i$$

for the equilibrium of total $M$, and

$$\frac{V}{S} \cdot \frac{dM_i^*}{dt} = P_o M_o^* - P_i M_i^*$$

for the rate of change of internal $M^*$, where $V$ is cell volume, $S$ is cell surface, and the suffixes $i$ and $o$ distinguish internal and external concentrations of the ion $M$, and an asterisk denotes labelled $M$. The $P$'s are the two permeability constants.

Krogh[1] discussed $P_i$; but Conway[4] pointed out that $P_o$ is the figure which measures the amount of $M$ entering the cell per unit time and area, when the external concentration of $M$ is unity. As the concentration can be measured in arbitrary units per unit volume, the result is that $P_o$ expresses the amount entering the cell in terms of the quantity of $M$ per unit volume in the solution; and if $P_o$ is a true constant, the quantity entering the cell per unit time and area will be linearly related to the concentration of $M$ in the external solution. We have found that this is the case in the physiological range of potassium and sodium concentrations, and $P_o$ for sodium is about 0·0004 cm. hr.$^{-1}$ and for potassium about 0·0038 cm. hr.$^{-1}$.

A full description of the methods and results will appear later.

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## *In vitro* Effect of Penicillin on Prothrombin Activity of Bovine Plasma

Moldavsky, Hasselbrock and Caterno[1,2] have recently reported that both oral and intramuscular injections of penicillin consistently shorten the coagulation time of normal blood and produce a non-retractile clot. They also observed decreased bleeding-times in patients receiving penicillin. J. H. Lewis[3] investigated more thoroughly the effect of penicillin on blood coagulation in both normal and hæmophiliac subjects. *In vitro* tests indicated that oral and intramuscular administration of penicillin did not have any effect on the blood-coagulating mechanism in either, in spite of high plasma penicillin levels. His *in vitro* tests to determine the effect of penicillin at various concentrations on the coagulation time of normal and hæmophiliac blood showed no change on the coagulation time.

In view of the contradictory nature of such results and the clinical application of Moldavsky, Hasselbrock and Caterno's[1] finding ("the possible use of penicillin as a hæmostat and the danger of intramuscular clotting"), the influence of penicillin on prothrombin activity was investigated.

*In vitro* experiments conducted in this laboratory have shown that penicillin at a concentration of 3,400 units and more increases the prothrombin time of bovine blood plasma, while concentrations lower than this appear to decrease the prothrombin time. The effect of penicillin at lower concentrations is not, however, very significant. Further work is in progress. The result of a typical experiment is given in the accompanying table.

Incubation at 37° C. for 2 hours

| Final concentration of penicillin (Oxford units) in the total volume of the mixture (1·4 c.c.) containing 0·4 c.c. of bovine plasma | Prothrombin time (in sec.) of 0·5 c.c. of resultant mixture |
|---|---|
| 19,500 | 120 |
| 10,200 | 70 |
| 3,400 | 42 |
| 1,700 | 34 |
| 425 | 30 |
| 106 | 30 |
| Control | |
| 0·4 c.c. plasma plus 1·0 c.c. distilled water | 37 |

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## Symbiotic Micro-organisms of Aphids and Fixation of Atmospheric Nitrogen

Many insects have associated with them specific micro-organisms, often present in special organs, which are passed on from generation to generation. Their function is in most cases unknown. In many instances where it has been possible to rear sterile insects lacking their symbionts, these have been stunted in growth and deformed, in other cases such insects have been found to develop in an apparently perfectly normal manner[1]. Fraenkel and Blewett[2] have shown that the poor growth of sterile larvæ of certain beetles, without their usual symbionts, may be restored to normal by the addition of certain factors of the vitamin B complex. In this case the role of the symbionts appears to be to provide the insect with these substances. It has been suggested from time to time, and more recently by Toth, that the symbionts are in many cases capable of assimilating gaseous nitrogen from the atmosphere. In his monograph[3], Toth concludes that a large number of insect species, including aphids, are able to fix nitrogen with the aid of their symbionts.

The direct experimental evidence for this conclusion rests on what is called 'the surviving system technique'. In this technique, aphids are ground up in a nutrient solution containing glucose and oxaloacetate, incubated at a suitable temperature and *p*H, and the increase in nitrogen content of the system (assumed to be due to fixation by the symbionts) measured by micro-Kjeldahl analysis. Following Toth's procedure exactly, I have measured the changes in total nitrogen content of such 'surviving systems' produced by grinding young individuals from actively multiplying colonies of either *Myzus persicæ* or *Doralis fabæ* in a nutrient medium ($MgSO_4$, 1 gm.; $Na_2CO_3$, 1 gm.; glucose, 5 gm.; oxaloacetic acid, 1·3 gm.; $CaCO_3$, 2 gm.; in $M/20$ phosphate buffer, *p*H 7, to 1 litre). These cultures were incubated, with shaking, either at 15° C. or 24° C. In all cases no increase in nitrogen content was observed—occasionally nitrogen was lost. Such

cultures are by no means sterile, and the nitrogen gains observed by Toth might equally well be ascribed either to the symbionts or to contaminant micro-organisms.

A further series of experiments was carried out in which young feeding colonies of *Myzus persicæ* or *Doralis fabæ* were left in an atmosphere of oxygen and nitrogen containing 31·5 per cent of the stable isotope nitrogen-15. After 20–64 hr. the insect material, together with leaf material controls, was assayed for nitrogen-15. No uptake of nitrogen-15 by the insects could be detected. An uptake of nitrogen gas equal to 0·03 per cent of the total nitrogen content of the insects would easily have been observed. It is apparent that the aphids used in these experiments showed no trace of nitrogen-fixing activity.

The question remains whether, in view of their high rate of proliferation, aphids can obtain enough nitrogenous foods from the plant to balance their nitrogen economy. After considering the ratios of protein to carbohydrate in aphid food and excreta, Toth[3] considers this is not possible. He quotes the following figures of the composition of the solid material taken in and of that excreted.

| | Protein (per cent) | Carbohydrate (per cent) |
|---|---|---|
| Food | 1–2–(5) | 90 |
| Excreta | 3·5 | 93 |

However, if Maskell and Mason's[4] figures for the amounts of nitrogen and carbohydrate in the sieve tubes of cotton plants are representative, the amount of nitrogen taken in must be much higher. They found such sieve tubes to contain 1 gm. nitrogen/100 ml. water and 5·95 gm. carbohydrate/100 ml. (ratio $\frac{\text{total nitrogen}}{\text{carbohydrate}}$ = 16·8 per cent). Furthermore, to compute the nitrogen balance of the insects, it is also necessary to know their rates of feeding and of proliferation. By following the increase in weight of single aphids (*Myzus persicæ*), Lea, Markham and K. M. Smith (unpublished) found the rate of uptake of food by a single aphid feeding on tobacco leaves to vary between 9 μgm. and 35 μgm./hr., with a mean of 25. Assuming the density of the food solution to be 1, and using the data of Maskell and Mason, it is seen (taking the mean rate of food uptake) that this corresponds to an uptake of combined nitrogen from the phloem of at least 0·25 μgm./hr. The total nitrogen content of an aphid is about 14·5 μgm. These aphids would thus double their nitrogen content in 58 hr. They were producing few offspring, and this doubling period falls well within the wide variability in rates of aphid multiplication. (Nitrogen lost by excretion has been neglected in this calculation, as it would appear to be negligible compared with that taken in.) It is interesting to note here that more than a hundred years ago Boussingault[5], from measurements of nitrogen contents of food and excreta of a cow, a horse and a turtle-dove, concluded that these animals do not fix nitrogen.

Finally, the mere fact that Peklo[6], from a study of the morphology of the symbiotic micro-organisms of aphids, places these in the *Azotobacter* group, gives no direct evidence that they are capable of fixing nitrogen.

From the above experiments the conclusion must be drawn that aphids do not take up nitrogen from the air. I wish to thank Dr. A. S. McFarlane for supplying the nitrogen-15, and Dr. Bentley, of the National Institute for Medical Research, for carrying out the nitrogen-15 assays.

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## Activation of Unfertilized Sea Urchin Eggs by Trypsin

Previous workers[1,2] have reported that commercial trypsin, crystalline trypsin and chymotrypsin are all able to activate the nuclei of unfertilized sea urchin eggs. The elevation of fertilization membranes has also been reported after treatment with low concentrations of crystalline trypsin[1]. In unfertilized *Pomatoceros* eggs, crystalline trypsin and chymotrypsin cause the formation of typical fertilization cones, but do not activate the nuclei[3].

As it is of interest to know to what extent the cytoplasm and the surface of the egg are involved in the parthenogenetic activation of sea urchin eggs by proteolytic enzymes, a reinvestigation of the whole subject has been undertaken, and a preliminary account of the results is given below.

The experiments described have been carried out on the eggs of *Psammechinus microtuberculatus* (Blv.). A 0·5 per cent solution of undialysed commercial trypsin (Kahlbaum) at *p*H 7·8–8·0 produced nuclear changes in 50–100 per cent of these eggs after two to four hours. The extent to which the nuclei were activated showed some variation, due, no doubt, to variations in the maturity of the eggs, taken from various females. The effect of the trypsin on the nuclei was to make them become enlarged but still with a distinct nuclear membrane. In some eggs this was followed by disintegration of the nuclear membranes and monaster formation. Within this space of time nuclear division rarely took place. After 5–8 hours irregular cleavage occurred in up to 60 per cent of the eggs.

When placed in hypertonic salt solution (0·6 c.c. of 2·5 *N* sodium chloride to 2 c.c. of egg suspension) the trypsin-treated eggs containing activated nuclei became spherical with smooth surfaces, as occurs in freshly fertilized eggs after similar treatment and in contrast to the wrinkled surfaces of unfertilized and unactivated eggs. This must indicate changes in the cortical layers of the eggs[4,5]. Angular plasmolysis, the characteristic response of older fertilized eggs to this treatment, did not occur.

After 4–6 hours there was found on the surface of trypsin-treated eggs a thin layer, presumably of extruded cortical material. During normal fertilization, cortical material is extruded and participates in the formation of the fertilization membrane (cf. ref. 2). The layer of extruded material may indicate a slight activation of the egg surface in the direction of the formation of a fertilization membrane; but a fertilization membrane cannot be formed as the vitelline membrane, which forms the basis of the fertilization membrane, is digested by trypsin of this strength[6].

The hyaline layer, which is differentiated after normal fertilization, is broken down rapidly in trypsin

solution, and when fertilization occurs in the presence of trypsin the hyaline layer is not formed[6]. It is unlikely, therefore, that the layer of extruded material has any affinities with the hyaline layer.

Experiments with crystalline trypsin and chymotrypsin gave no activation of the nuclei or of the surfaces of the *Psammechinus* eggs, and thus the results of previous workers have not been confirmed, at least in respect to this species.

The results with commercial trypsin show that activation is more comprehensive than was formerly thought, the activation involving the surface of the eggs as well as the nucleus. The destruction of the surface layers of the egg by the trypsin prevents, however, the possible expression of the surface phenomena associated with normal fertilization.

The negative results with crystalline trypsin and chymotrypsin indicate that the activating substance in commercial trypsin may be neither trypsin nor chymotrypsin, as was formerly supposed.

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## Soil Phosphate Uptake as Influenced by Phosphatic Fertilizer

PERENNIAL rye-grass was sown in small pots (12 cm. in diameter) on August 3, and harvested on October 22, 1947. Seven plants per pot were grown, and six replicate pots per treatment were provided. Two top soils from North Auckland Province, both very poor in available phosphate, were used. The Maunu loam derived from basalt is akin to a lateritic type; the Wharekohe silt loam, derived from an early tertiary claystone, is a mature podsol. They are classified respectively as "immature red brown loam" and "strongly podsolized yellow earth" by the New Zealand Soil Survey. Primary calcium phosphate labelled with radioactive phosphorus was used as fertilizer in amounts equivalent to 100 mgm. $P_2O_5$ per pot, this being roughly equal to a rate of 100 kgm. $P_2O_5$ per hectare, calculated on an area basis. Dry-matter yields, total phosphorus and radioactivity were determined in the harvested plants.

The accompanying table gives some of the results obtained, the figures referring to sums of six replicates (pots). A full account will be published elsewhere.

| | Maunu loam | | Wharekohe silt loam | |
|---|---|---|---|---|
| 1 per cent citric acid soluble $P_2O_5$ per cent | 0·009 | | 0·001 | |
| $P_2O_5$ added (mgm.) | 0 | 600 | 0 | 600 |
| Yields (tops and roots) in gm. | 0·61 | 8·56 | 0·84 | 13·24 |
| $P_2O_5$ taken up by plants (mgm.) | | | | |
| From fertilizer | 0 | 37·2 | 0 | 95·5 |
| From soil | 1·1 | 3·3 | 1·65 | 14·5 |
| Total | 1·1 | 40·5 | 1·65 | 110·0 |

Thus plants that received the phosphatic fertilizer took up three to eight times as much $P_2O_5$ from the original soil phosphate as the controls.

This experiment was finished when there came to hand a paper by Spinks and Barber[1], who, using a radioactive tracer technique, obtained similar results with wheat. The occurrence of this phenomenon can thus be accepted as well established.

To my knowledge, the first hint that phosphate fertilizer might in some circumstances stimulate the uptake of phosphorus from the soil came from Leopold Zaleski[2] (the paper appeared probably in the twenties, but unfortunately at the moment I am not able to give a more exact reference). In his experiments small doses of superphosphate placed beneath oat seeds increased the phosphorus uptake by more than the amount of phosphorus contained in these small doses, thus giving an apparent re-recovery or utilization of more than 100 per cent. Without a tracer technique, however, it would not have been possible to prove a stimulating effect of this kind in conditions less definite than those of Zaleski's experiment.

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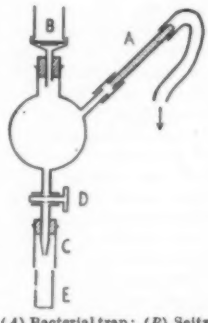
## A Simple Apparatus for Adding Seitz-Filtered Components Aseptically to Embryo Culture Media

IN attempting to culture excised immature plant embryos, it is frequently desirable to avoid autoclaving the nutrilite components (for example, malt extract). These are usually Seitz-filtered separately and transferred by pipette to the individual culture vials containing the previously autoclaved sugar and inorganic components of the medium. To workers unskilled in bacteriological methods, this represents a tedious and time-consuming operation.



(*A*) Bacterial trap; (*B*) Seitz filter; (*C*) glass shield; (*D*) stop-cock; (*E*) culture vial

The apparatus illustrated is simpler to handle and satisfactorily avoids contamination. Essentially it consists of a separatory type funnel with side vent to which can be attached a simple bacterial trap *A*, namely, a glass tube with one end partially closed, filled with loosely packed cotton-wool. The apparatus is autoclaved before use, the apertures at *B* and *C* being plugged with cotton-wool, and the stop-cock *D* closed. During filtration, suction is applied through *A*, the partially sealed orifice preventing withdrawal of the contents of the trap. After filtration, the shield *C* is unplugged and the requisite number of drops (previously calibrated) added to the culture vials through the stop-cock *D*. The diameter of the shield should be slightly greater than the diameter of the culture vials *E*, which can then be inserted as illustrated while the filtrate is added. The bacterial trap *A* allows air to pass into the apparatus without contaminating the filtrate as the latter is withdrawn.

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## Correlation Between Lewis Blood Group and Secretor Character in Man

A NEW blood group character, designated as 'Lewis', was first described by Mourant[1], who found that the blood of 25 per cent of English people contained the Lewis factor, and that this group character is independent serologically of the *ABO*, *MN*, *Rh*, *P*, Lutheran and Kell systems. Somewhat later, Andresen[2] described 'anti-L sera' which are now known to be anti-Lewis sera. These sera agglutinated the red cells of 21 per cent of adult Danes and the cells of about 70 per cent of Danish children less than seven months old. Andresen put forward the view that the Lewis blood group was inherited by means of two allelomorphic genes L and l, the three possible genotypes being LL, Ll and ll. The data observed indicated that anti-Lewis serum agglutinates the red cells of adults if they are of genotype LL only, whereas in young children the genotype Ll is also detectable.

I have observed that the Lewis blood group character is intimately correlated with the secretor–non-secretor status within the *ABO* classification, Lewis-positive adult persons being non-secretors. This statement is based on the results obtained in the determination of the secretor type of twenty Lewis-positive and forty-two Lewis-negative persons. The twenty Lewis-positive persons were all non-secretors. Of the Lewis-negatives, forty-one were secretors and one (group $A_1$) was a non-secretor. On the basis of probability, it would appear that this result cannot be attributed to chance. In this sample the proportion of non-secretors is somewhat in excess of that found in the general population; there has, indeed, been a deliberate selection of Lewis-positive persons.

The classification of persons as secretors or non-secretors for the *A*, *B* and the so-called *O* factors was made by agglutination inhibition tests, using freshly collected and boiled saliva as inhibiting agent. The salivas from persons of group *A* (6 Lewis-positive, 19 Lewis-negative), *B* (1 Lewis-positive, 2 Lewis-negative) and *AB* (1 Lewis-positive, 2 Lewis-negative) were tested for inhibition of α- and β-agglutinins respectively. The salivas from persons of group *O* (12 Lewis-positive and 19 Lewis-negative) were examined with the following 'anti-*O*-sera': (1) Serum from a rabbit immunized with blood group substance obtained and purified from ovarian cysts of secretors of group *O*[3]. (2) A selected specimen of serum from the eel *Anguilla vulgaris*[4,5]. (3) Serum from a chicken immunized with suspensions of *Shigella Shigæ*[6]. Group *O* erythrocytes believed to represent the genotypes LL, Ll and ll of Andresen were agglutinated to the same titre by these sera.

Preliminary observations show that the salivas of Lewis-positive persons (non-secretors of the *A*, *B* and *H* substances) may inhibit the action of a strongly agglutinating dose of anti-Lewis serum at a dilution of 1 : 100 or more. The salivas of most Lewis-negative persons, possibly heterozygotes, show some power of inhibiting the action of Lewis agglutinins. Other salivas from Lewis-negative persons do not neutralize anti-Lewis serum.

Witebsky and Klendshoj[8] observed that the water-soluble substances in the secretions of those persons, classified as non-secretors owing to their inability to secrete the *A*, *B* or '*O*' (now called *H*)[7] substances, were nevertheless similar in general chemical properties to the *A*, *B* and *O* substances. A mucoid material possessing chemical characters common to the group substances and isolated from pseudomucinous ovarian cyst fluids obtained from secretors and non-secretors has been examined. The material inhibits completely and at high dilutions the action of two to three strongly agglutinating doses of anti-Lewis serum on Lewis-positive *O* cells[8]. Investigations in this field are being continued.

I wish to convey my sincere thanks to Dr. W. T. J. Morgan, Dr. R. R. Race, Miss Ruth Sanger and Dr. A. E. Mourant for their valuable advice and help.

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## Equations of Piezoelectricity

RECENTLY, Dr. Richard K. Cook[1] has criticized as errors certain equations in my book[2] in which mixed units occur. In particular, he points to my Eq. (1), which expresses the energy stored in a crystal upon which an arbitrary mechanical strain and an arbitrary electric field are impressed. His assertion that "the reader is therefore obliged to examine closely the origin of the formulæ he uses" would be more convincing if he had cited instances in which an incorrect conclusion has been drawn from Eq. (1). This equation is:

$$\xi = \tfrac{1}{2}\sum_{h}^{6}\sum_{i}^{6} c_{hi}S_hS_i + \tfrac{1}{2}\sum_{k}^{3}\sum_{m}^{3}\eta''_{km}E_kE_m + \sum_{m}^{3}\sum_{h}^{6} e_{mh}E_mS_h + \tfrac{1}{2}\frac{J\rho C\theta^2}{T} + \theta\sum_{h}^{6} q_hS_h + \theta\sum_{m}^{3} p_mE_m,$$

where the $c$'s are elastic constants at constant field, the $S$'s are strain-components, $\eta''$ is the dielectric susceptibility of the clamped crystal, $E$ the field-strength, $e$ a piezo-electric stress-constant, $J$ is the mechanical equivalent of heat in ergs per calorie, $\rho$ is the density, $C$ the specific heat in cal.gm.$^{-1}$ deg.$^{-1}$, $T$ the absolute temperature, $\theta = \Delta T$ is a small change in temperature, $q$ is a thermo-elastic constant, and $p$ a pyro-electric constant.

Dr. Cook's objection is to the use, in the same equation, of the co-ordinate $S$ along with $E$, which may be regarded as a generalized force.

It should be recalled that mixed units occur in some of the classical equations in thermodynamics. In piezo-electric theory, following the method of thermodynamics, they were used by Voigt, for example, on p. 816 of his "Lehrbuch der Kristallphysik"; they occur in the treatment of electro-elastic phenomena by Born, and in such handbooks as that of Geiger and Scheel and the "Encyclopädie der mathematischen Wissenschaften". There is therefore nothing novel in the use of mixed units in certain energy equations. It is true that in interpreting the derivatives of my Eq. (1) it is necessary —as was also the case with Voigt—to distinguish carefully between internal and externally impressed

stresses; the same may be said of my Eqs. (243) and (243*a*). Equations (1), (243) and (243*a*), although thermodynamically correct, are not such that their derivatives lead immediately to the desired results. Nevertheless, the relations between mechanical and electrical quantities, in the commonly accepted form of coupling equations with stresses applied externally, are obtained by appropriate treatment of these derivatives, as may be seen by inspection of my Eqs. (186), (246), (248*a*) and (250).

On page 246 of my book are four equations analogous to the expressions for the internal energy $U$, the Helmholtz function $A$, the Gibbs function $G$, and the enthalpy $H$. Although the analogies are not exact, the equations were formulated as leading to the defining expressions for the piezo-electric coefficients.

More recently, I have undertaken the formulation of a set of equations in the form of exact differentials, such that, when integrated, the partial differentials lead directly to expressions for the coupling between thermal, mechanical and electrical quantities. It turns out that this can be done very simply by adding to the thermal and mechanical terms in the $dU$, $dH$, $dA$ and $dG$ functions, further terms expressing the electrical contribution to the energy. In the equations below, the field-strength $E$ and polarization $P$ are treated as generalized force and co-ordinate, respectively. Absolute temperature and entropy are denoted by $\theta$ and $\sigma$, while the stress and strain matrices are denoted by $T$ and $S$. With solids, $-T$ and $S$ replace the pressure $p$ and volume $v$ that are used in the case of gases or vapours; here each component of $T$ is considered as positive when it tends to produce a positive component of $S$. The equations are:

$$\begin{aligned} dU &= \theta d\sigma + TdS + EdP \\ dH &= \theta d\sigma - SdT + EdP \\ dA &= -\sigma d\theta + TdS - PdE \\ dG &= -\sigma d\theta - SdT - PdE \end{aligned}$$

From Maxwell's relations, and assuming (over a limited range) known linear relations between $\theta$ and $\sigma$, between $T$ and $S$, and between $E$ and $P$, one can integrate and find equations for $U$, $H$, $A$ and $G$. (The extension of the thermodynamic equations to include electrical parameters was developed independently by Prof. K. S. Van Dyke and discussed by him in "A Manual of Piezoelectric Data", Fifth Semi-Annual Report to U.S. Army Signal Corps, Part II, under Contract No. W28–003 sc–1556 with Wesleyan University, January 20, 1948. I am indebted to him, and also to Dr. J. S. Mendousse, for helpful suggestions.) The partial derivatives of these equations yield at once the usual equations for coupling, in which the externally applied stress and the actual field in the crystal are given directly. These coupling equations may be regarded as *equations of state*. The equation for $dG$ leads to Eq. (2) in my book. The equations for $dA$, $dU$ and $dH$ lead, respectively, to modifications of my Eqs. (1), (243) and (243*a*).

It is easily shown that $dA$ as expressed above is related to $d\xi$, as obtained from my Eq. (1), as follows:

$$d\xi = -dA + 2c^E SdS.$$

The fact that in using Eq. (1) a discrimination had to be made between internal and external piezoelectric stresses may be said to be due to the presence of the term $2c^E SdS$. If I had written Eq. (1) with the sign of the first term reversed, $d\xi$ would have been the same as $-dA$ and all stresses in the derivatives would have been external.

Equations similar to the foregoing may also be written, in which the polarization $P$ is replaced by the displacement $D$.

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[2] "Piezoelectricity" (McGraw-Hill Book Co., Inc., New York, 1946).

## Pulsating Stars and Nuclear Energy

THE explosion in an 'atom bomb' occurs when two masses of uranium-235, each too small to retain sufficient neutrons to start a chain reaction, are brought into juxtaposition within a certain critical volume. A similar state of affairs will account for the phenomena of pulsating stars, but with this difference, that whereas in terrestrial experiments the reacting material is dissipated by the force of the explosion, in the interior of a star those heavy nuclei which have escaped fission during the course of one explosion are reconcentrated by gravitational attraction and are available as a neutron source, or for fission, a few days later.

The data necessary for mathematical investigation have not yet been fully released, but it may be assumed that heavy nuclei will gravitate toward the centre of a star when convection currents and other types of instability have subsided. With the immeasurably larger quantities of available matter as compared with terrestrial standards, the critical conditions of explosion will be quite different. Instead of a few grams or kilograms of highly concentrated fissile material brought together into a critical volume measured in cubic centimetres, it is possible that neutron generation will exceed dissipation when the necessary minimum number of tons is concentrated into a space of thousands or millions of cubic kilometres. If the pressure of radiation engendered by nuclear fission is great enough to overcome the structural forces in the star, it will reach the surface and carry away with it a halo of gaseous material, and this is clearly seen in the case of a nova. If, however, the gravitational field and the opacity of the star are sufficient to withstand the pressure, the greater part of the explosion will be kept within the bounds of the star, and after a period of expansion and increased luminosity the star will collapse under its gravitational field, until the reactive materials have again been brought together in sufficient concentration to start another cycle.

Although mathematical proof is not yet available, this suggestion will account in general terms for the successive phases in the cycle of the Cepheid variables —the rapid expansion with little change of surface brightness, due to a wave of compression from within; the slower collapse under gravitational force, showing irregularities due to secondary waves; the quantitative relation between absolute magnitude and period; and the almost limitless supply of energy. In the case of supernovæ, quantitative considerations of the energy radiated support the belief that the origin of the energy is a nuclear chain reaction[1].

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# ADSORPTION BY MONTMORILLONITE, AND ITS RELATION TO SURFACE ADSORPTION

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THE nature of the forces giving rise to the intra-crystalline swelling of montmorillonite has been several times discussed. The recent work of Bradley[1] and of myself[2,3,4] on the swelling caused by adsorption of organic liquids enables us to get a clearer view of the problem, because these liquids form well-defined complexes in which the influence of the exchangeable ions is less marked than with water.

The questions which have to be answered are: (*a*) Why do the organic molecules penetrate into the montmorillonite 'crystals'? (*b*) Why is the resulting expansion limited in extent? X-ray photographs show that the molecules between the structural sheets of the clay mineral are not in the form of a normal liquid, but are arranged in well-marked layers, reminiscent of the layer-structure which has been postulated for adsorbed films on the actual surface of crystals[5]. On this basis it may be suggested that one factor in the formation of these complexes is a repulsive force which comes into operation when crystalline surfaces are brought very close together in a liquid medium, due to their collecting layers of strongly adsorbed molecules[3]. In order to explain the observed equilibrium an attractive force must also be found.

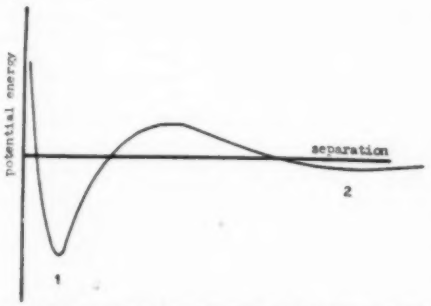


Fig. 1. Hypothetical potential energy curve for two particles in ionizing medium. Minimum 1 due to adsorption repulsion; minimum 2 due to ionic repulsion

Verwey and Overbeek[6] have calculated the variation of potential energy with separation for two parallel charged plates, based on: (i) the repulsion due to the ionic clouds, essentially as calculated by Langmuir[7]; and (ii) the long-range van der Waals' attraction between the plates. In suitable circumstances, their curves show a shallow minimum of potential energy at considerable distances of separation (50–500 A.), followed by a maximum and a monotonic decrease as the plates are brought closer together. If to the terms considered by Verwey and Overbeek we add a term corresponding to the free energy of adsorption of the superficial layers of molecules, we will get a further (rapidly dying out) repulsive contribution, and we might thus expect a second minimum in the total potential energy curve corresponding to separations of the order of a few molecular diameters (Fig. 1).

It is noteworthy that such a minimum has been postulated by Verwey and Overbeek[6] in order to explain the phenomenon of repeptization, and to get it they had to invoke the Born repulsion. The considerations given here suggest that a minimum may be obtained at separations which are quite large in comparison with those at which the Born repulsion will be able to act. Verwey and Overbeek's treatment, of course, was confined to lyophobic systems, and particle-solvent interactions were specifically excluded; but it is doubtful if the formation of adsorbed surface layers of molecules is confined to systems that would be described as 'lyophilic', and it may well be quite a general phenomenon.

When one attempts, however, to express the above ideas in quantitative form, certain difficulties appear. There are no adequate data on the change of surface-free energy with adsorption of organic liquids by montmorillonite, but Bangham and Mosallam's[8] careful measurements enable this quantity to be obtained for mica in contact with methanol, benzene and carbon tetrachloride; and in view of the close structural similarity of mica and montmorillonite[9], it does not seem unreasonable to suppose that these results will apply fairly well to montmorillonite also. The lowering of free energy for a given quantity of organic liquid adsorbed is given by Bangham's form of Gibbs' expression $RT \int \Gamma d\log p$, taken between the appropriate limits, and all the quantities here can be derived from Bangham and Mosallam's data. We need, of course, to know the value of $\Gamma$ corresponding to one, two, . . . layers; and to calculate this I assumed (i) that the density of the adsorbed layers is the same as that of the normal liquid, and (ii) that the orientation and thickness of the adsorbed molecules are those given by direct X-ray spacing measurements on the montmorillonite complexes[4]. The general correctness of the assumptions is suggested by the fact that the completion of successive layers as thus determined corresponds in most cases with points of discontinuity in Bangham and Mosallam's adsorption isotherms.

In applying these results to the montmorillonite complexes, one must allow for the fact that, unlike the surface films on mica, they have no free liquid surface (by adding the free surface energy of the liquid). The final result for methanol is shown in Fig. 2, curve I, which gives the lowering of free energy per unit cell as a function of the separation of the montmorillonite sheets, the value for no separation being arbitrarily set equal to zero. On the same graph is shown the potential energy variation due to van der Waals' attraction, as calculated from Verwey and Overbeek's formula[10] with $A = 10^{-12}$ (curve II). Clearly this energy is far too small in comparison with the adsorption energy to give a position of equilibrium at any suitable distance. The assumed value of $A$ is likely to be too large rather than too small, so the van der Waals' force cannot account for the observed equilibrium unless the adsorption energy is seriously in error, which seems unlikely. There must therefore be another type of attractive force at short separations.

The possibility of this force being electrostatic in origin is worth considering. At larger separations, of course, the net force due to the ions is repulsive, and the treatment of Langmuir[7] essentially applies. But here we are dealing with the case where not only the Gouy, but also the Stern layers may overlap, and the essential assumption underlying the application of the Poisson–Boltzmann equation, that each ion moves in the mean potential field of all the ions, may break down. The ions will then rearrange themselves in a single layer, so that each one occupies a certain 'cell', bounded on either side by the two interacting surfaces, from which other ions are excluded. The force between the sheets will then be attractive, and its potential will increase uniformly with separation, at a rate depending on the dielectric constant of the medium. Assuming this is the same as for *solid* methanol, we get curve III in Fig. 2, and combining it with the curve of adsorption free energy we get curve IV, showing a stable position with two layers of methanol molecules between the montmorillonite sheets, which is what is actually found.

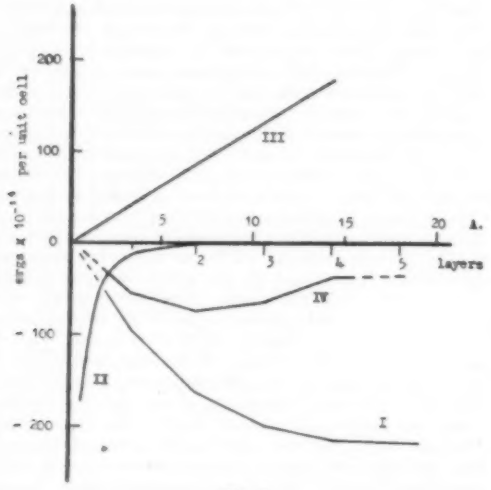


Fig. 2

The electrostatic force, unlike the van der Waals' force, is thus of the right order of magnitude to explain the observed effect. Its actual value is subject to error, because no account has been taken of the effect of segregation of the cations towards one or other of the two sheets. With 'bare' cations, this effect should lead to a considerable lowering of the attractive force at 10 A. separation. It is probable, however, that the cations will co-ordinate polar groups (or residual water molecules) in such a way as to increase their effective size, and make this effect less marked. At separations greater than about 10 A., such segregation is bound to set in, reducing the attractive force, until finally, with the attainment of the normal Gouy layer distribution, the force becomes repulsive. Actual values for the separation in organic complexes[4] vary up to about 11 A. The case of adsorption of large complex ions, for example as studied by Gieseking[11], is, of course, quite a different one.

I am grateful to Dr. D. H. Bangham, Dr. S. Levine and Dr. R. K. Schofield for conversations on the subject of this communication, but they are not responsible for the opinions expressed in it.

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## HIGH VACUA

### GLENEAGLES CONVENTION

ON October 12 and 13, the Society of Chemical Industry sponsored a convention on high vacua under the presidency of Sir Charles Darwin, director of the National Physical Laboratory. It is worthy of record that there was much appreciative comment at the choice of Gleneagles for the meeting, and the view was expressed widely that the so-called 'country house party' system in which interested persons meet in conditions of intimacy for a time with little or no distractions has much to recommend it.

The meetings opened with a brief historical survey and some personal recollections by Sir Charles Darwin. His remarks on the interaction of pure science and technological practice reminded his listeners that modern developments have produced a situation in which the contribution of the highly expert technician is now an essential to success. As he rightly remarked, it is no longer practicable for the physicist or the chemist in his research laboratory himself to make the apparatus he requires for his own use.

Dr. Saul Dushman, of Schenectady, dealt with the scientific aspects of vacuum technique. He referred to the advances resultant on the advent of the vacuum tungsten lamp and its developments, the magnetron, and fluorescent-screen cathode-ray tubes. The introduction of high-vacuum technique has enabled the production of high-energy accelerators such as the cyclotron, betatron and synchrotron. Many of the developments, the result of war-time demands, would astonish those concerned with these matters even ten years ago, he remarked, and it is fair to say that the technique has now emerged from the experimental stage to take its place as a valuable tool for the physicist. Oil-vapour pumps are available with speeds of exhaust ranging up to, and above, 7,000 litres/sec. (15,000 cu. ft./min.) and producing ultimate vacua ranging from $10^{-2}$ microns to $10^{-3}$ microns mercury pressure.

Dr. Dushman spoke of the difficulties of producing accurate gauges for such measurements; he believes that, in some cases at least, the limit of measurement has, for the time being, been reached.

Dr. J. C. Swallow and Dr. J. S. Gourlay, of Welwyn, discussed the applications of high vacua in the paint and plastics industries. The first part of their paper dealt with the technique of metallization now becoming increasingly important on a large scale. This technique involves the deposition *in vacua* of a thin partially transparent layer of metal over a surface.

The metal is evaporated from a small source so placed that it impinges on the surface at an oblique angle. Irregularities on the surface produce local variations in the thickness of the metal layer, and the shadows cast by these enable their heights to be calculated. A very interesting process has also been developed for coating polymethyl methacrylate with aluminium. This is used to make the spherical plastic mirrors of diameters from 3 in. to 11 in. used in television projection.

In high-vacuum distillation it is hoped that the progress recently made will soon permit the separation of the various molecular species in a pure state. In plastics, short-path distillation can now be employed in the manufacture of a high molecular weight plasticizer by removing the ester from the reaction before its completion, which would require such high temperatures as to cause discoloration. In general, in a reaction $A + B = C + D$, the procedure is to remove by high-vacuum distillation $C$ or $D$, and the technical requirement of purer and still purer plasticizers of high molecular weight may well lead to the adoption of this procedure.

An interesting suggestion by Dr. Swallow was to consider not only the use of high-vacuum technique in the production of plastics, but also the use of plastics in high-vacuum apparatus, particularly for gaskets, inspection windows, and sheathing.

Dr. R. S. Morse, of Cambridge, Mass., contributed two papers on high-vacuum dehydration and distillation. An exciting feature of his papers was the evidence of applying highly complex processes to the production of very large quantities of materials like penicillin, sera, and the like. The cold-trap vapour pumping system in which air pressure is reduced to less than 50 microns of mercury with a mechanical pump is now in use on a large scale for drying biological preparations. For the production of penicillin and streptomycin, however, diffusion pumps are used to reduce the free-air pressure to 1–10 microns. The vapour is condensed and continuously removed as ice by rotating scraper blades. In an effort to eliminate all mechanical problems and convert a desiccant system to a continuous operation, continuous liquid chemical absorption processes are being studied. In these, free air is removed to 10–100 microns and vapour is continuously absorbed with a hygroscopic medium. The medium is afterwards reconcentrated and, at reduced temperature, again circulated and additional water vapour removed. There are particular and unique problems involved in designing high-vacuum drier equipment, such as the heat transfer to the product. Efforts have been made also to reduce the drying time to a minimum, and Dr. Morse suggested that the time is approaching when high-vacuum drying operations will compete with more usual procedures such as spray drying.

Dr. E. W. M. Fawcett, of the Paint Research Station, discussed the application of high-vacuum distillation to the processing of triglyceride oils. Molecular distillation is limited generally to distillands in the molecular weight range 300–1,200; it has a poor fractionating power and is rather high in cost. The rapid development of solvent fractionation processes may well also limit the application of the distillation process in some directions. It would appear, said Dr. Fawcett, that molecular distillation is a process for the special case, such as the recovery of vitamin A from fish liver oils, and, in his view, it is unlikely to be applied generally on a commercial scale. In contradistinction to its rather limited scope in commercial-scale practice, however, molecular distillation as a laboratory process has great possibilities and will undoubtedly find increasing usage with the perfection of the necessary high-vacuum technique.

Mr. R. A. Stauffer, of Cambridge, Mass., spoke on vacuum metallurgy, where much of the interest is still in the research and development stage. The two major advantages of processing metals *in vacuo* are that metals so processed are protected from reaction with gases, and those metallurgical reactions in which gaseous products are formed from solid or liquid reactants are favoured by maintaining a low gas pressure over the reactants. During the War very large quantities of magnesium were produced in Canada and the United States using a high-vacuum technique, but most of the plants are now closed because of high operating costs and poor plant locations. It is probable, said Mr. Stauffer, that lithium metal will be produced in the near future using vacuum techniques, and the production of other metals of the alkali and alkaline earth metal group have been studied, but so far only on a small scale. Small quantities of barium and cæsium are being made but the amount is limited to a few tons per year.

It is theoretically possible to drive reactions involving dissociation of metallic compounds which give rise to gaseous by-products; but in practice the number of metals which might be prepared by those techniques is extremely limited. Many of the halides can be dissociated by heating to high temperatures, but these reactions cannot be readily driven by vacuum techniques since most of the halides are quite volatile themselves and are removed, along with the halogen formed, as a by-product. A promising application for vacuum vaporization is in conjunction with the 'Kroll' process whereby titanium chloride is reduced with magnesium, forming a mixture of titanium, magnesium, and magnesium chloride from which titanium must be recovered. A vacuum-vaporization technique is used for removal of magnesium and magnesium chloride in order to avoid a leaching operation which would contaminate the titanium.

Vacuum technology as applied to the design and construction of vacuum furnaces is progressing rapidly and new techniques for melting are being developed. There appears, however, to be little to be gained in the mechanical properties of metals by vacuum heat-treating operations.

Mr. Stauffer concluded by saying that the advantages to be gained by the use of vacuum technology have not been fully evaluated and in some cases the equipment required for its industrial application to metallurgical processes is not fully developed.

The final session was devoted to two papers, one by Dr. C. R. Burch, of Bristol, who spoke of developments arising out of experiments on vacuum distillation, considered as an illustration of the impact of one technology on another; and the other was by Prof. M. L. E. Oliphant, of Birmingham, who spoke of high vacua in nuclear physics, mentioning in particular some of the practical difficulties of work in this field. Dr. Burch's talk was largely historical for, as he explained, he has not worked on the subject for some years.

Prof. R. V. Jones, of Aberdeen, in his concluding remarks, directed attention to some of the main points made by the speakers and in the discussions. The convention concluded with an expression of thanks to those who had made it possible.

## BEHAVIOUR OF PIGS

IN the course of experimental work of a nutritional and physiological character at the National Institute for Research in Dairying, R. Braude has noted some interesting features about the behaviour of pigs (*Bull. Animal Behaviour*, No. 6; January 1948). These observations have been recorded without any attempt to fit them into the framework of existing theories of behaviour, and, in the words of Dr. E. S. Russell, they merely "serve to illustrate what is the most characteristic feature of behaviour, namely, that the animal tries or strives to do something specific, that it seems to achieve some end, to satisfy some need".

On one occasion a wooden block resembling a sow with two rows of rubber teats fitted at the approximate spot was put into the farrowing pen. It was placed as near as possible to a sow which was farrowing. Not one of the fourteen piglets born on this occasion showed any interest whatsoever in the dummy teats, while all were keenly interested in the real teats, and as usual fought for access to them.

Another observation concerns the behaviour of piglets in suckling usually from the same teat. Donald has stated that "this ability must be founded mainly on sight, with some capacity to recognize the feel of a nipple playing a secondary part. Hearing may be disregarded, and so may a sense of smell, for pigs placed with a foster mother will, if they are able, take up the position they had on their original mother." From the start it seems to be of importance to the piglets to obtain a correct position on the udder. The quality of the teats varies to such an extent that it is not surprising that in the early stages of suckling the piglets are prepared to fight for access to the good ones and those successful occupy them permanently. The resultant growth-rate of the victors indicates the importance of this selection. With a small litter the best teats are soon discovered and continue to be sucked throughout lactation, while the poor ones are completely abandoned, and gradually dry off. With large litters some of the piglets never secure the chance of settling down at a good teat, and this fact seems to be mainly responsible for the usual one or two 'runts' in a large litter.

The effects of massaging the udder by the piglets just before the actual suckling have also been observed. With cows, the composition of the milk obtained depends on whether the udder has been previously stimulated or not, while in pigs there is evidence that the milk obtained by draining it off is only half as rich in fat as that obtained by the young pigs suckling. That the controlling factor is of a hormonal nature has been confirmed by Kon, Thompson and Braude, and by means of 'Pitocin', a proprietary extract from the posterior lobe of the pituitary which contains the oxytocic principle, it is now possible to milk a sow in much the same way as a cow. To milk the sow after treatment with 'Pitocin' the sow has to be roped. Here an interesting aspect of behaviour is shown. It is well known that a sow will struggle against roping and that once caught she will try to get rid of the rope. What she usually does, however, is to pull back with all her strength, and by so doing makes the noose only more secure. On the other hand, if she were to walk forward—and there is nothing to stop her doing so—the effectiveness of roping would be completely lost. For some unknown reason this never occurs. The explanation that she can see the holder of the rope in front of her and tries to back away from him has proved to be untrue. The holder of the rope has been concealed and two people have been placed behind the sow. Those behind have had to push with all their strength to make the sow step forward.

Other observations show that, once a sow has done a long walk to the piggery where the boar is kept, she seems to learn the route and needs little guiding on subsequent occasions. Sows usually keep to the road and are careful when leaving it, making sure that the path they are taking is safe for them.

Except when mating, two grown pigs brought together will fight each other until one establishes a complete supremacy; sometimes even death may result. Mixing young weaners from different litters invariably results in a fight; but these soon settle down together. On the whole, however, pigs like company, and cases have been known when separated pigs have had to be brought back to their mates because "they went in seclusion on what amounted to a hunger strike". It is also known that a strong pig will keep a weaker one away from the food trough, while in the pen the favourite place for sleeping is occupied by the stronger. On occasions when two lots of pigs are mixed together in one pen, the usual fight is followed by the relegation of the defeated to the dunging passage.

That pigs quickly become accustomed to new routines which have to be introduced into an experimental piggery is shown by the following. Pigs have to be weighed at frequent intervals, sometimes daily and at least once weekly. At first it is difficult to get them into the weighing pen; but, after a few times, they walk into it of their own accord as soon as the door of the weighing pen is opened. A clearer example of a conditioned reflex is quoted by Braude from Denmark. There, a certain pigman arrives at his piggery in the morning and, as his first job, rings a heavy bell. This was a signal for all the pigs in that piggery to get up and go out into the dunging passage to defecate and urinate. The procedure was repeated as regularly in the afternoon, and this practice kept the piggery clean.

Information on the feeding habits of pigs has also been collected and shows the pig is a selective feeder. The now well-known story of its liking for copper is re-told, together with further evidence which has been collected by experimental inquiry.

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## NATURE AND CONSTITUTION OF GLASS

AT the recent joint meeting of the International Commission on Glass and the Society of Glass Technology, a symposium was arranged having as a general title "Some Aspects of the Nature and Constitution of Glass". Fifteen papers, presented by American, British and Continental investigators, ranged widely over the subject and raised, in each of three sessions, lively and sustained discussions.

In an introduction to the series of papers, Prof. W. E. S. Turner reviewed the important historical developments of the subject and referred to the place of theory in glass technology. Whereas for some forty years or more Tammann's theory of glass as a supercooled liquid had done much to account for many of the properties of glasses, greater insistence was now being laid, as indicated in the paper "Solid

Liquids" submitted by Dr. F. W. Preston (Butler, U.S.A.), on the elasticity and therefore solid character of glass, with a definite atomic structure like a crystalline material, although without the regular repetition of the structural units found in a crystal.

Mr. S. M. Cox (Sunderland), in his paper on "An Elementary Kinetic Theory of Dilute Silica Glass", developed further a kinetic theory he had previously outlined. He employed an ingenious short film to illustrate the movements of the atoms at different temperatures and to explain his concepts. He suggested that an important term in equations describing the variation of physical properties with temperature is the proportion of loosely linked oxygen atoms, and he showed that the equation for this proportion can be derived from a simple distribution of potential energy curves. Equations relating the electrical conductivity with temperature, and of viscosity with temperature, were derived, and it was shown that the calculated results compare favourably with known experimental data.

Dr. G. O. Jones (Oxford) stressed the view that the study of glass can make a great contribution to the theory of the liquid state and the theory of melting. He outlined the present state of knowledge of the property-temperature changes in the transformation range and indicated the need for experimental work designed to provide full thermodynamic data. He also emphasized the need for experimental work on the kinetics of the crystallization process in glasses, on the stabilization phenomena, on the chemical durability of very thin films, and on the need for a theory of viscosity which would include the delayed elasticity effect. In the discussion, Prof. A. Smekal (Darmstadt) referred to work in Germany during the last eight years, particularly to the electron microscope examination of fracture surfaces, and to substances which have their transformation ranges near the melting point.

Mr. J. E. Stanworth (Sheffield) reviewed recent ideas of glass from the point of view of their ionic structures, referring particularly to the use of the electro-negativity values of the elements as a guide to their behaviour in a glass structure, and to the unusual behaviour of lead, bismuth and thallium, three ions which can be introduced in large percentages into glasses because of their high deformabilities.

Dr. J. M. Stevels (Eindhoven) discussed the relation between the dielectric losses and the constitution of glass, first describing briefly the theory of Gevers and du Pré, and the manner in which the theory explains the formulæ of Strutt and von Schweidler for the dependence of loss angle on temperature and frequency, respectively. Dr. Stevels pointed out the need for measurements at temperatures approaching absolute zero, and then outlined his theory of the effect of composition on losses, developing an equation which agrees with known data at a frequency of about $10^6$ cycles per second.

Dr. S. P. Varma first presented a paper written in collaboration with Prof. W. A. Weyl (Pennsylvania State College), and also one by Dr. F. L. Jones and Dr. N. J. Kreidl (Rochester, N.Y.), both papers dealing with the optical properties in relation to constitution. Dr. Varma emphasized the fact that cations with electronic structure not of the noble gas type have bonding properties to neighbouring ions markedly different from corresponding noble gas-type ions. A series of curves showing molar refraction against composition, for silicate and borate glasses, emphasized the high contribution of lead ions as compared with barium and strontium ions, and of zinc ions as compared with magnesium ions.

A paper by Mr. J. B. Murgatroyd (Greenford) (read by Dr. E. J. Gooding) described the delayed elastic effect in glass fibres and showed that this effect increases with decrease in fibre diameter. Some conclusions were made concerning the arrangement of the bonds in fibres, and the relation between the structure of chilled and liquid glass.

Mr. R. W. Douglas (Wembley) outlined a theory of viscosity for simple glasses, based on the idea that there are two equilibrium positions (separated by an energy barrier) for each oxygen atom, the application of a stress enabling the oxygen atom to move from one potential minimum to the other; together with the thermal agitation of the atoms, this movement can provide flow. An equation for viscosity derived from this theory was used to compare calculated with known data, and the conclusion drawn that in complex glasses other atoms than the oxygens (for example, the sodium atoms) are probably involved in the flow mechanism.

Dr. G. O. Jones also spoke on the flow of glass, with particular reference to temperatures below the transformation range; he described the experimental results of strain-time measurements, and suggested that a model representing accurately the observed values could be either a number of Maxwell models in parallel or Voigt models in series, using a suitable distribution of relaxation times. In the discussion, Prof. A. Smekal referred to the measurements in Germany of the rate of crack propagation, using ultrasonics, and to theoretical work showing that the Griffith flaw theory can explain the continuous distribution of relaxation times and elastic after-effects.

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# FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

## Monday, December 13

BRITISH MUSEUM (NATURAL HISTORY) (at the Royal Scottish Museum, Chambers Street, Edinburgh), at 5.30 p.m.—Mr. Douglas A. Allan: "The Geology and Scenery of Scotland" (Swiney Lectures).* (Further Lectures will be given on December 15 and 17, January 17, 19, 21, 24, 26 and 28.)

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Dr. E. Lind: "Cheshire Meres".*

UNIVERSITY OF LONDON (at the Institute of Education, Malet Street, London, W.C.1), at 5.30 p.m.—Mr. Corder Catchpool: "Education for International Understanding—Central Europe".*

## Tuesday, December 14

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS GROUP (at Gas Industry House, 1 Grosvenor Place, London, S.W.1), at 2.30 p.m.—Dr. D. D. Eley: "Biological Polymers". (Members of the Biochemical Society are invited.)

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Dr. J. D. Craggs: "Some Limitations of Particle Counting with Electron Multipliers and Geiger Counters".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Frequency Modulation versus Amplitude Modulation" (to be opened by Mr. H. L. Kirke).

INSTITUTION OF NAVAL ARCHITECTS (joint meeting with the INSTITUTE OF MARINE ENGINEERS, at 85–88 The Minories, London, E.C.3), at 5.30 p.m.—Prof. L. C. Burrill: "Latest Developments in Reversible Propellers".

ILLUMINATING ENGINEERING SOCIETY (at the Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Dr. J. N. Aldington: "The Gas Arc—a New Light Source".

INSTITUTION OF STRUCTURAL ENGINEERS, LANCASHIRE AND CHESHIRE BRANCH (at the College of Technology, Manchester), at 7 p.m.—Mr. R. A. Foulkes: "The Use of Light Alloys in Structures".

SOCIETY OF DYERS AND COLOURISTS, SCOTTISH SECTION (at the St. Enoch Hotel, Glasgow), at 7 p.m.—Mr. M. R. Fox: "The Relationship between the Chemical Constitution of Vat Dyes and their Dyeing and Fastness Behaviour".

ROYAL INSTITUTE OF CHEMISTRY (in the Material Research Laboratory, Philips Electrical, Ltd., New Road, Mitcham Junction), at 7.15 p.m.—Mr. R. J. Hercock: "The Theoretical Basis of Photography".

BRITISH CULTURAL COMMITTEE FOR PEACE (at St. Pancras Town Hall, Euston Road, London, N.W.1), at 8 p.m.—Discussion on "Culture and Peace—with Reference to the Congress at Wroclaw" (to be opened by Prof. J. D. Bernal, F.R.S., Mr. Peter Blackman and Dr. Olaf Stapledon).

## Wednesday, December 15

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 4.45 p.m.—Scientific Papers.

ROYAL METEOROLOGICAL SOCIETY (joint meeting with the ROYAL ASTRONOMICAL SOCIETY, in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Discussion on "Post-Glacial Climatic Change".

INSTITUTE OF WELDING, NORTH LONDON BRANCH (at East Ham Technical College, Barking Road, London, E.6), at 7.30 p.m.—Open Discussion on "Welding Methods".

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "Relations between Scientists and Administration" (to be opened by Mr. F. A. Cobb, M.P., Dr. R. Cockburn and Dr. C. Gordon.

## Thursday, December 16

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. B. Katz: "The Electrical Properties of the Muscle Fibre Membrane": Dr. M. F. Perutz: "An X-Ray Study of Horse Methæmoglobin", Part 2.

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. G. Szegö: "Recent Investigations on Electrostatic Capacity and related Quantities".

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.15 p.m.—Messrs. R. C. Trumbull, W. Hardiek and E. G. Lawford: "Notes on the Treatment of Pyrites Cinders at the Plant of the Pyrites Co., Inc., Wilmington, Delaware".

BRITISH INSTITUTION OF RADIO ENGINEERS (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6 p.m.—Mr. J. B. Birks: "The Physical Applications of Microwaves".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. D. J. Lyons: "Present Thoughts on the Use of Powered Flying Controls in Aircraft".

TEXTILE INSTITUTE, LONDON SECTION (at the Holborn Restaurant, 218 High Holborn, London, W.C.1), at 6.30 p.m.—Discussion on "Technical Education" (to be opened by Dr. J. C. Withers).

BRITISH INSTITUTE OF RADIOLOGY (at 32 Welbeck Street, London, W.1), at 8 p.m.—Dr. Denis Taylor: "British Radiation Monitoring Equipment".

## Friday, December 17

INSTITUTE OF NAVIGATION (with the ROYAL GEOGRAPHICAL SOCIETY, at Kensington Gore, London, S.W.7), at 4.30 p.m.—Opening by H.R.H. the Duke of Edinburgh of an Exhibition "Navigation through the Ages": at 5.30 p.m.—Sir Robert Watson-Watt, F.R.S.: "Radio and Position". (The Exhibition will be open at 10.30 a.m. until January 31.)

PHYSICAL SOCIETY, LOW-TEMPERATURE GROUP (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 4.30 p.m.—Third Annual General Meeting; at 5 p.m.—Prof. D. M. Newitt, F.R.S.: "The Use of Thermodynamic Diagrams in Industry".

PHYSICAL SOCIETY, OPTICAL GROUP (at the Institute of Physics, 47 Belgrave Square, London, S.W.1), at 5 p.m.—Scientific Papers.

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Mr. H. A. V. Bulleid: "Cinematography in Engineering".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, BIOLOGICAL METHODS GROUP (at Gas Industry House, 1 Grosvenor Place, London, S.W.1), at 6.15 p.m.—Annual General Meeting: at 6.30 p.m.—Scientific Papers.

SOCIETY OF INSTRUMENT TECHNOLOGY, MIDLAND SECTION (at the Arden Hotel, New Street, Birmingham), at 7 p.m.—Mr. E. Simpson: "Optical Devices—Simple Optical Devices Applied to Weighing and Measuring".

## Friday, December 17—Saturday, December 18

ASSOCIATION OF UNIVERSITIES OF THE BRITISH COMMONWEALTH (at the University of London, Senate House, London, W.C.1).—Conference of the Universities of Great Britain and Northern Ireland.

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# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

RESEARCH ASSISTANT IN BIOCHEMISTRY, and a TECHNICAL ASSISTANT IN BIOCHEMISTRY—The Secretary, Department of Pharmacology, Medical School, The University, Birmingham 15 (December 18).

UNESTABLISHED POSTS at the National Physical Laboratory, Teddington, in connexion with work which is being undertaken to promote the use of automatic control devices in industry—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.384/48A (December 18).

SENIOR LABORATORY TECHNICIAN with special experience in biochemistry—The Group Pathologist, Archway Hospital, London, N.19 (December 18).

MATHEMATICIANS (Senior Scientific Officer grade) at a Ministry of Supply research and development establishment near London for (*a*) theoretical investigation into the detonation of explosives, (*b*) numerical analysis of problems in applied mathematics, and (*c*) work on fluid mechanics—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.391/48A (December 18).

MATHEMATICIANS and MATHEMATICAL PHYSICISTS (Scientific Officer grade) for work in solid and fluid mechanics and high-speed gas dynamics, statistical mechanics and quantum theory, statistics, in Ministry of Supply research and development establishments in and near London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.392/48A (December 20).

LECTURER IN INDUSTRIAL AND GENERAL PSYCHOLOGY in the University of Western Australia—The Agent-General for Western Australia, 115–116 Strand, London, W.C.2 (December 20).

LECTURER IN THE DEPARTMENT OF BIOCHEMISTRY—The Registrar, The University, Liverpool (December 24).

RESEARCH ASSISTANT IN THE DEPARTMENT OF CHEMISTRY—The Registrar, The University, Manchester 13 (December 24).

ASSISTANT EXPERIMENTAL OFFICERS to assist with performance testing of aircraft at a Ministry of Supply establishment in Wilts—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.393/48A (December 30).

PROFESSOR OF PHYSICS, and a LECTURER IN BACTERIOLOGY, in the University of Queensland—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (December 31).

LECTURER IN APPLIED PSYCHOLOGY in the Joint Department of Psychological Medicine of King's College and the Royal Victoria Infirmary—The Registrar, King's College, Newcastle-upon-Tyne (December 31).

LECTURER (Grade III) IN CHEMISTRY—The Registrar, Queen Mary College, Mile End Road, London, E.1 (December 31).

PHYSICIST (either Lecturer or Assistant Lecturer grade) in the Department of Textile Industries—The Principal, Municipal College of Technology, Manchester (January 3).

READER or SENIOR LECTURER IN BIOCHEMISTRY in the University College of the West Indies—The Secretary, Special Committee of the Senate on Higher Education in the Colonies, University of London, Senate House, London, W.C.1 (January 15).

CIVIL ENGINEERS (Hydro-electric Design Section), a MECHANICAL ENGINEER (Hydro-electric Design Section), and MECHANICAL ENGINEERS (Mechanical Section), in the New Zealand Government Department of Works—The Official Secretary, Office of the High Commissioner for New Zealand, 415 Strand, London, W.C.2 (January 15).

SENIOR LECTURER or LECTURER IN ANATOMY—The Registrar, The University, Sheffield (January 22).

CHAIR OF APPLIED CHEMISTRY, the CHAIR OF APPLIED PHYSICS, and the CHAIR OF APPLIED MATHEMATICS, in the New South Wales Technical University—The Agent-General, New South Wales Government Offices, 56 Strand, London, W.C.2 (January 25).

SENIOR LECTURER or LECTURER IN MATHEMATICS, and a SENIOR LECTURER or LECTURER IN PHYSICAL CHEMISTRY, in the University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (February 15).

CHAIR OF ANTHROPOLOGY in Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (March 1).

LECTURER or ASSISTANT LECTURER IN ANATOMY in the University College of the West Indies—The Secretary, Senate Committee on Higher Education in the Colonies, University of London, Senate House, London, W.C.1 (March 1).

BOTANIST (male) to undertake cytogenetical research on sugar cane at the British West Indies Central Sugar Cane Breeding Station—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1.

ASSISTANT SUGAR TECHNOLOGIST in the Imperial College of Tropical Agriculture, Trinidad—The Secretary, Imperial College of Tropical Agriculture, Grand Buildings, Trafalgar Square, London, W.C.2.

DEMONSTRATOR (woman) IN THE DEPARTMENT OF ANATOMY—The Secretary, Charing Cross Hospital Medical School, 62 Chandos Place, London, W.C.2.

ORGANIC CHEMISTS (2) to undertake research initially on the chemistry of vulcanization, a PHYSICAL CHEMIST to study problems arising in the oxidation of rubber, a COLLOID or PHYSICAL CHEMIST for fundamental studies in surface chemistry, a COLLOID or PHYSICAL CHEMIST for applied research on rubber latex, a RUBBER TECHNOLOGIST, and a LATEX TECHNOLOGIST—The Director of Research, British Rubber Producers' Research Association, 48–52 Tewin Road, Welwyn Garden City, Herts.

CANDIDATE (with a university degree in chemistry) to organise collation and indexing of chemical abstracts and to supply information to the chemistry division of the Atomic Energy Research Establishment, Didcot—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.1021/48A.

BIOLOGICAL ASSISTANT (with degree in physiology or zoology)—Mrs. Simpson, Courtauld Institute of Biochemistry, Middlesex Hospital, London, W.1.

PHYSICIST (preferably with some research experience) to study rheological properties of yarns and filaments—The Secretary, British Rayon Research Association, Bridgewater House, 58 Whitworth Street, Manchester 1.